SCIENCE TEACHER'S WORLD

Teacher's edition of Science World • October 14, 1958

New trends in science teaching

A Rip Van Winkle of a science teacher who went to sleep ten years ago and awakened today might rub his eyes in amazement.

His astonishment would be understandable. No longer is the public oblivious to the science teacher's existence. No longer is he just taken for granted by the school administration. No longer do professional scientists look down their noses at him.

The secondary school science teacher has, in fact, become an important man in the eyes of others. National, state, and local governments, private foundations, boards of education, and industry — all are making an effort to help him upgrade his professional competence, to give him "experience" in industry, and to stimulate him into making the content of his courses up to date. To this end, summer jobs are opening up, weekend seminars are being organized, and a variety of institutes are being established. All because of Sputnik.

The effects are already being felt in the classroom. What follows is a brief rundown of the many changes that are taking place in the teaching of the various high school science subjects.

Biology

To stay attuned to what is going on in his own area, the high school biology teacher must know what is happening in other areas. Changes in the teaching of elementary school science and even of college-level science are bound to affect his own work and professional responsibilities. Here are some current developments and their possible effects on high school biology teaching.

Elementary science: In the elementary schools, the teaching of science has been unorganized, with no particular pattern or sequence. This casual approach is now being replaced by carefully thought-out Kindergarten-through-Sixth-Grade programs. Greater emphasis is being placed on the physical sciences and less on "nature study." This poses two questions of concern to the biology teacher: (1) Will nature study be crowded out to the extent that students will come into high school biology classes with even less knowledge of living things? (2) Will future students have a better background for understanding the chemistry and physics involved in high school biology courses?

"Modernization" of biology: Under the auspices of the National Academy of Sciences-National Research Council, thirty selected college and high school teachers were brought together from all parts of the nation. Their job: to compile a source book of Laboratory and Field Studies in Biology for Secondary Schools. After tryouts in many schools, these studies will be refined and published. Watch for the publication announcement.

The talented student: Many schools are organizing seminar-type classes. These consist of discussion of "original papers" in science and project work in the laboratory. Some schools are setting up "experimental biology" classes to devote full time to student projects.

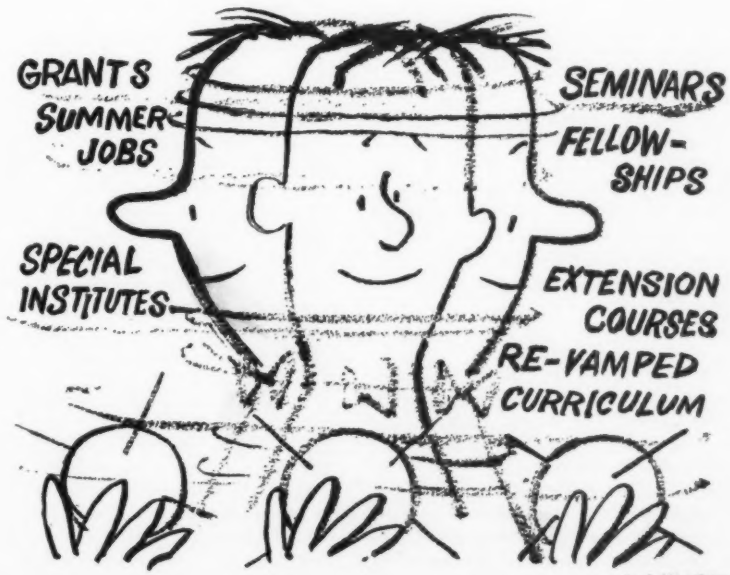
The slow learner: The trend toward making special provision in biology for the slow student continues. Courses are being modified or specially composed for him. So are textbooks and workbooks.

Physics

Ever since the beginning of World War II, there has been an active ferment in physics teaching. First came the pre-induction physics course covering machines and electricity. This was followed by courses in electronics, aviation, and automotive physics.

After the war most of these passed into limbo. The ferment subsided, only to be stirred up again by the Ford Foundation experiment: college physics courses were introduced to high schools capable of handling them. The experiment, now over, was a success. The idea is growing continuously under the general name of "advanced standing" physics.

Paralleling this experiment has been the growth of "applied physics" courses for what some people call the less capable students. These courses include watered-down standard courses,



— Jack Woolhiser

STW Contributing Editors: Alexander Joseph and Zachariah Subarsky

with emphasis on applications. Physical science courses that combine physics, chemistry and the earth sciences are also increasing. They are usually aimed at the average student.

Most physics courses, however, are still 1890 models with twentieth-century trimmings. It was in 1890 that the Committee of Ten began to standardize high school courses. Since then the concept of the basic physics course has never really changed. Instead, new technological developments have been added to the course almost year by year until the physics textbook bulges with technology.

About five years ago a committee of AAPT (American Association of Physics Teachers) made a study of the existing high school physics textbooks. It found that more space was devoted to technology than to physics.

In 1956 a group at M.I.T., under the leadership of Professor Jerrold Zacharias, gained the support of the National Science Foundation for an attempt to remodel the high school physics course. The twofold purpose: to reduce content so that more time could be devoted to selected areas; to change the approach to that of the physics of today — modern physics. The underlying philosophy was to develop a course that would give the college-bound student a view of the physical world as it is revealed today.

The course, as eventually developed by a group of thirty high school physics teachers and a slightly larger group of physicists, consists of: an introduction to the nature of physics and the makeup of the physical world, optics and waves, mechanics, electricity and magnetism, and "modern" physics. Special textbooks, laboratory guides, films, and an extensive teacher's manual were prepared.

During the 1957-58 school year the course was tested in eight different high schools. Then, last summer, some three hundred teachers were exposed to all phases of the program. During the 1958-59 school year local in-service institutes are being set up in twenty metropolitan centers for the same purpose. The experimental program will be introduced into 270 high schools this fall.

Chemistry

High school chemistry teaching seems to be moving along three parallel tracks. The middle track is represented by the basic course. This, like the basic physics course, was set up at the end of the last century. Since then, material on nuclear science and on new technological developments has been added. But there has been no real change in the teaching of basic concepts of chemistry.

The lower track is occupied by applied chemistry courses. These got their start during the 1930's when there was a strong move toward "consumer chemistry" courses. Such courses are still taught in many schools. They have had some effect on the work done in the standard course.

Broader courses in applied chemistry have also made an appearance. Several well-known textbooks and manuals have been written for these courses. Applied chemistry courses are usually taken by students who might not do so well in the standard course.

On the upper track is the advanced chemistry course. Schools that are in the Ford Foundation program, for example, offer a course in elementary college chemistry.

In many schools that offer more than one year of chemistry, two types of analytical courses are given: qualitative analysis and semi-microchemistry. The qualitative course is roughly similar to a college course of its type. The semi-microchemistry course uses simple, inexpensive miniature equipment and small quantities of chemicals. In some cases, semi-microchemistry is used in a qualitative analysis course. Its simplified techniques are also being used by enterprising teachers in the laboratory phase of the standard chemistry course. The entire complement of semi-microchemistry laboratory equipment fits into a small wooden cabinet.

For the past few years the Manufacturing Chemists Association has been supporting a program to improve the teaching of high school chemistry. Among the most valuable materials prepared by the Association is a series of experiments, now numbering some 35, called open-ended experiments. These don't lead the student to a "conclusion." Instead, they guide him into new areas and problems, offer him an opportunity to extend himself, and give him a better understanding of the way a scientist really works.

Another project aimed at improving chemistry teaching is under way at the University of Florida. There, a series of teaching films on high school chemistry, covering a full year's work, are being made.

In many respects, the three tracks along which chemistry teaching is moving fall into the pattern proposed by Dr. James B. Conant in his recent proposals for comprehensive high schools. Obviously, the nature of the student body and the local educational climate, in addition to the skill of the teachers and the budget, are factors in determining the feasibility of such a program.

General science

Although the teaching of science in the elementary grades is growing, only a tiny percentage of elementary students receive well rounded instruction. It is therefore in the general science class that most pupils get their first real taste of science. For this reason, the general science teacher carries an important responsibility. He is the one who can kindle the spark that will lead a student to take other science courses. On the other hand, he might well lose for the nation a potential scientist. The general science class is important as a place where science talent can first be singled out. It is important, too, as the place where our future voters will receive their science backgrounds.

The teaching of general science is more varied than that of the other secondary school sciences. Almost all states have a prescribed syllabus that usually allows for wide variations to meet local conditions. In many schools, the content of the course is determined by the textbook used.

One slow, but certain, tendency is the gradual movement of certain simpler areas from the other sciences into general science. At the same time, much of the elementary science taught from the middle grades up bears a striking resemblance to the general science taught in the junior and senior high school. For the past 150 years this downward shift has been slowly taking place.

Some schools have experimented with earth science as a Ninth-Grade subject, but have generally found that pupils in this grade are not mature enough to get maximum benefit from the work.

In some general science programs, the cyclic, or spiral, approach is popular. Topics that will be more fully developed in later courses are taken up in general science. But this sometimes backfires on the upper-grades teacher. He finds that students may lack interest in the topic when met a second (or sometimes a third) time. Some students will have already followed the topic through. Others will simply feel that they "have had that before." In still other cases the teacher of the earlier course may actually have exhausted the subject.

Because of this drawback, many teachers are not happy with the cyclic approach. And the drawback is likely to be accentuated. As elementary science develops, much of what is today's general science will become a second cycle. So, eventually, instruction from Grades 1 to 12 will have to be completely revamped.

MEMO

To: Science teachers

Subject: Ways to use this issue of SCIENCE WORLD in the classroom

Progress report on IGY

EARTH SCIENCE TOPICS: glaciation, ocean currents, tides, climatology, mountain formation
CHEMISTRY TOPIC: sources of strategic substances
GENERAL SCIENCE TOPIC: IGY program

This article brings into focus for the student the most dramatic scientific enterprise in the history of mankind. Teachers of earth science will find the account useful in enriching and bringing up to date their teaching of the topics listed above. The general science teacher who initiates a class project on IGY will find the article (together with Ben Bova's article on interplanetary space travel) a means of stimulating an abiding interest in IGY and a source of fascinating information for his students. Chemistry teachers usually point out to their classes that sea water is a source of magnesium and other elements of economic importance. They can now extend this reference to include the valuable substances on the ocean *floor* discovered by the Scripps Institution expedition.

Class discussion

1. What ocean currents in the Atlantic and the Pacific have recently been discovered?
2. Where are the deepest holes in the ocean? What theory has been advanced to explain the fact that none of these are more than 35,000 feet deep?
3. Explain the differences in heat flow from various parts of the ocean floor.
4. How are 14-day tides accounted for?
5. What methods are used to measure the thickness of ice in Antarctica?
6. How would the melting of the antarctic ice affect other land areas of the world?
7. What reasons are there for believing that Antarctica may be more than a single land mass?

Interplanetary travel

BIOLOGY TOPICS: photosynthesis, respiration, circulation, nervous system
GENERAL SCIENCE TOPICS: earth's atmosphere, solar system, photosynthesis, solar energy, transportation, communication

The biology teacher can use this article as supplementary reading for students on any of the topics listed above. A good point to emphasize is this: the emergence of life from water to dry land probably took millions of years. By comparison, the emergence of man from the earth's atmosphere to space is taking place in almost an instant. Yet the two transitions are similar: each involves a change in environment, but no change in the essential conditions for life — the need for water, food, oxygen, and a proper temperature.

The general science teacher can use the article in connection with any of the topics listed above. In courses that include a unit on space travel or on the IGY program, the article will be particularly appropriate.

Class discussion

1. Compare the rocket and the satellite as "tools" for exploring space.
2. What should be found out about the space between the earth and the moon before an attempt is made to send a *manned* rocket to the moon?
3. What provisions will have to be made to keep a man alive on a trip to the moon?
4. How would a space station be furnished with electricity, food, oxygen?
5. Aside from being a jumping-off place for travel to the moon and the planets, of what use could a space station be?
6. How will space vehicles leaving a space station be propelled?
7. What are some possible advantages and disadvantages of the moon as a space station?

Winged words

BIOLOGY TOPICS: classification, vocabulary

Dr. Asimov's lucid article is especially timely at the beginning of the school year. Many biology teachers start their courses with a survey of living things. And they find it good pedagogical practice to point out to the class the significance of technical terms and the

usefulness of knowing their derivations. The article may be used to stimulate a number of student reports, investigations, and experiments.

Student reports

1. Compare the wings of a butterfly and a housefly; a beetle and a bee; a bee and a housefly; a bat and a bird; a pterodactyl and a bat.

2. Describe some birds and some insects that do not fly.

3. Tell how the Greek word *pteron* came to be applied to a plant, a mammal, a lizard, a chemical compound, and a vitamin.

Student investigations

1. Catch a housefly and examine its balancers with a magnifying glass.

2. Examine the wing of a housefly under a microscope to observe its "veins."

3. Examine the wing of a butterfly or moth under a microscope to observe its scales.

4. Examine with a magnifying glass a large feather of a bird to observe the "branches" and their "zippers."

5. Catch a full-grown grasshopper and observe its cover-wings and fan-wings.

6. Dissect the wing of a chicken to observe the arrangement of its bones.

Projects and experiments

1. Find out whether a housefly can fly without its balancers. Remove the balancers and compare its flight with that of a normal fly.

2. Work out a method of testing the strength of a bird's feather.

Mr. Binder's solid vacuum

GENERAL SCIENCE TOPICS: barometer, suction pump
PHYSICS TOPIC: high vacuums

This amusing science-fiction story can be used by the teacher as a point of departure for taking up any of the following:

1. The story of how the ancient and fallacious idea, "nature abhors a vacuum," was discredited by the experimental observations of Galileo and Torricelli in the late sixteenth and early seventeenth centuries.

2. The many phenomena in nature and the numerous applications in technology that involve reduced air pressure. Examples: how mammals and amphibia draw air into their lungs and how insects draw air into their tracheal tubes; how starfish manage to pull apart the tightly closed valves of the shellfish on which they feed; how ivy clings to the walls of buildings; how air is drawn into an automobile engine; how plungers clear clogged pipes; how vacuum cleaners take in dust; how airplanes are lifted into the air; how sailboats are pulled against the wind.

3. The challenging problem of producing high vacuums for scientific and industrial purposes. A perfect vacuum, as we know, has not yet been attained by man. Most of the air in a container may be pumped out, but the remainder defies displacement by mechanical means. Ingenious methods are used to obtain high vacuums. For example, some of the remaining molecules of air may be removed by causing them to combine chemically to form solid substances. Advances in electronic research and in high-vacuum phenomena are closely associated. The electron microscope, for instance, depends on specially designed high-vacuum pumps.

End to nuclear tests?

PHYSICS TOPICS: nuclear energy, radioactivity, sound waves, electromagnetic radiation
EARTH SCIENCE TOPIC: seismic waves
CHEMISTRY TOPICS: nuclear energy, radioactivity
BIOLOGY TOPIC: effect of radioactivity on man

This timely article deals with the methods of detecting nuclear weapons tests, as worked out by scientists at the Geneva conference.

Discussion questions

1. Why is international control of atomic-bomb explosions important to man?

2. How do the four methods of detection differ?

3. Why was this conference one of the most important of those in which scientists have taken part?

Experiments and projects

1. Build or borrow a simple Geiger counter. Use it to detect the amount of natural (or background) radiation present.

2. Have pupils build a simple seismograph. See the book of experiments in the National Academy of Science's IGY kit ($5.75).

3. Have students demonstrate an ultra-high-frequency oscillator and receiver to show that a signal can be received even if it occurs for a very short time.

4. In a room containing a sensitive barometer, produce a loud bass sound and observe the barometric change. A sensitive aircraft altimeter may also be used.

Important

Here's how to insure continued delivery of SCIENCE WORLD to your classroom:

1. If you have not yet entered an order, use the postage-free card bound into this issue to do so.

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The next issue, dated October 28, will be delivered on or before October 21. If that issue does not reflect your revised order, please bear with us. An overwhelming amount of clerical work is involved in revising orders, and our subscription personnel (being only human) sometimes cannot match the pace of incoming mail. Your order will be processed as quickly as possible, and you will be billed only for the revised order.

SCIENCE WORLD

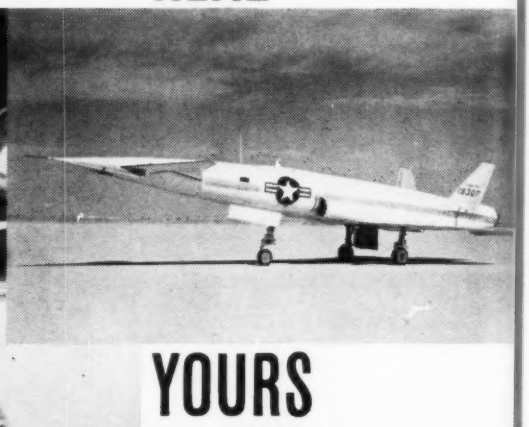
OCTOBER 14, 1958 • THE SCIENCE MAGAZINE FOR HIGH SCHOOL STUDENTS

SIX STEPS TO THE PLANETS

(see page 4)

A BRIGHT FUTURE BECOMES REAL WHERE THE AGE OF SPACE IS REAL

Your age is... the Age of Space! And you can build a bright future in this new age by training where the Age of Space is *real*... in the U.S. Air Force. Day to day, Airmen work with supersonic aircraft, rockets, advanced electronics, intercontinental missiles—and soon will work with manned vehicles for outer space. Here is your chance to get a flying start on life. For nowhere else is so broad and complete a range of Space Age specialty training available as in the U.S. Air Force. Get the complete details now. See your local Air Force Recruiter, or mail the coupon below.



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Heat into Electricity: Exciting advances at General Electric and Westinghouse in direct conversion of heat into electricity.

The Senses of Man: How many senses do you have? The answer (based on Bell's new TV program) will surprise you.

IGY: Round-up of IGY probing of space.

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On the Cover: A lunar reconnaissance vehicle, as seen by Convair Astronautics' Krafft Ehricke. Cover artwork, courtesy of Solar Aircraft Company.

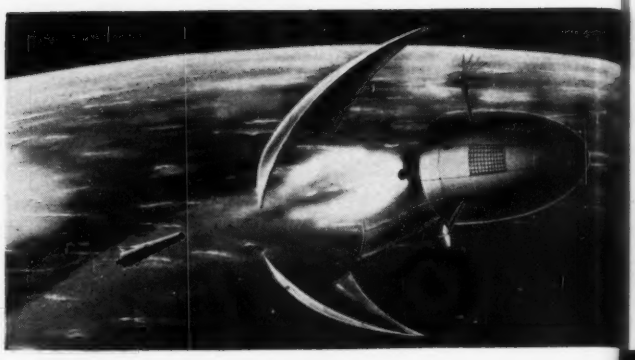
An editor's jottings

A new service for *SW* readers is initiated in this issue. The ever-popular Yours for the Asking column is now accompanied by a coupon (p. 28). To request material listed in the column, simply fill out the coupon, check the items you wish to receive, and mail us the coupon. We will forward your requests to the various organizations involved.

How are you fixed for science projects? You'll find our Young Scientists feature (p. 22) packed with suggestions and ideas. Also, we'd like to hear from you concerning your own projects, past and present. See instructions on page 24.

Driving to a football game? Be extra careful on the return trip. Twilight and darkness sharply reduce visibility — and the days are growing shorter and shorter.

Now is the time to enter your subscription to *SW* if you haven't already done so. To go on sending you *SW* we must hear from you or your teacher.



SIX STEPS TO INTERPLANETARY TRAVEL

By Ben Bova

Bigger and more powerful rockets strike many people as being the chief requirement for travel to the moon and beyond. But space flight, unfortunately, is not that simple. Actually, we'll have to take a number of carefully planned steps before embarking for a planet.

These steps have recently been outlined by members of the Astronautics Section of the Martin Astronomical Society. The society is composed of engineers and technicians who work for the Martin Company, which manufactures aircraft and rockets. Their activities, however, are completely separate from those of the Martin Company.

Members of the Astronautics Section are studying the problems of interplanetary travel. They believe that man must take six major steps before leaving the earth for other worlds. The steps are: (1) launching unmanned rockets and satellites; (2) sending unmanned rockets to the moon; (3) probing the fringes of space with manned rockets; (4) placing a manned satellite in orbit; (5) building a manned space station; and (6) sending men to the moon.

Obviously, we are now in the process of taking the first step. The second step may be under way by the time you read this. And we'll begin taking the third step early next year. It's entirely possible that all six steps will be completed in fifteen years. Before they are, however, much scientific data must be gathered and many engineering problems solved. For an understanding of some of the broad problems we will face, let's look briefly at each step.

STEP 1: unmanned rockets and satellites.

For more than ten years the United States and other nations have been sending up high-altitude research rockets. These rockets serve a dual purpose: (1) their electronic instruments send back information about conditions in or above the atmosphere; and (2) the rockets themselves test new engines and guidance techniques. Naturally, rockets can send back only a limited amount of information during their brief flight periods. It is here that man-made satellites, such as the Russian Sputniks and the American Explorers and Vanguard, have an advantage. They can provide continuous space data for long periods of time.

Along with scientific rockets and satellites, military ballistic missiles and other rocket weapons are paving the way to space travel. Though not primarily devoted to research, missile projects are helping develop the necessary engines, guidance systems, and basic rocketry know-how.

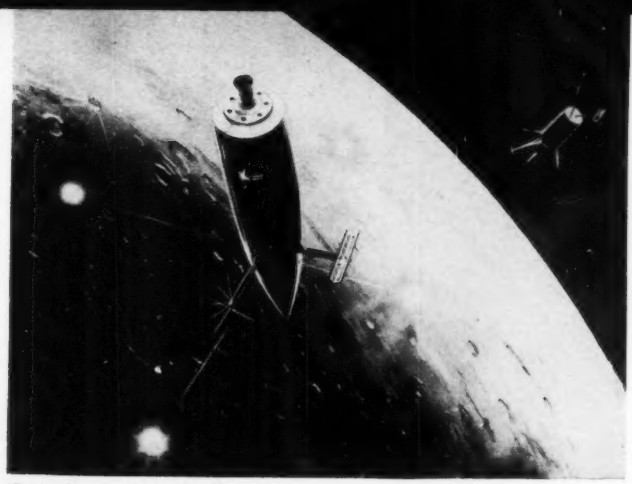
STEP 2: unmanned rockets to the moon.

Much practical knowledge can be gained from a rocket that hits the moon or orbits around it. Such a rocket, for example, can tell us a lot about cosmic-ray and meteor density between the earth and the moon and about the effect of solar radiations during the trip. These all pose dangers to man. What's more, a close-up of the moon will help scientists determine its gravitational field.

It's no secret that the rocket engines used in intercontinental ballistic missiles are powerful enough — on paper, at least — to be used in the first stage of a multi-stage vehicle making a one-way trip to the moon. The main problem in reaching earth's natural satellite is guidance. A very slight error could cause a robot ship to miss the moon entirely. The ship would then sail out into space.

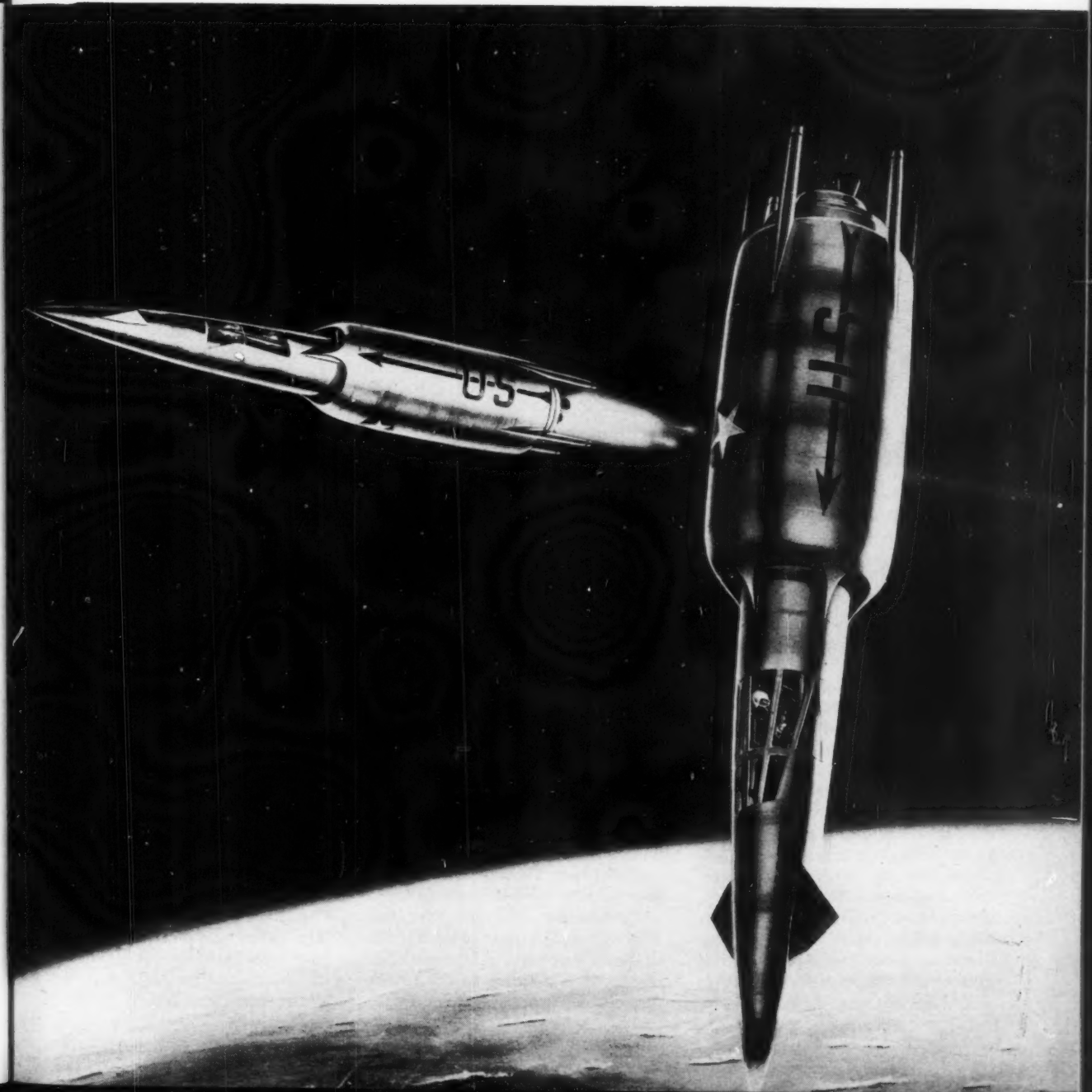
STEP 3: manned rockets.

Shortly after the first unmanned rocket is sent to the moon, man-carrying rockets will probably be



Illustrations by Nick Stamilla

FIRST THREE STEPS to planets are illustrated in these drawings. Step 1 (*far left*): large unmanned satellites, such as this one, will continue the gathering of data on upper atmosphere and outer space. Step 2 (*left*): robot rocket ships will explore moon. Ship in foreground is firing flares visible to astronomers on earth. Step 3 (*below*): man-carrying rockets will probe fringes of space.



probing the upper atmosphere and perhaps breaking into space itself. One such rocket, the X-15, is now being built by North American Aviation, Inc.

The X-15 has been described as a "space probe." Flying at speeds of up to 4,000 mph, this ship is expected to carry man to the fringes of space. Further development of this type of manned rocket could well result in the first manned spaceship.

When these first three steps are completed, man will be ready to tackle a gigantic problem: how to stay alive in airless, inhospitable interplanetary space. His problem might be compared to that faced by living creatures three hundred million years ago when they first invaded dry land after having successfully developed in the oceans.

STEP 4: manned satellites.

To study human survival in space, a manned satellite will undoubtedly be put into an orbit around the earth for extended periods of time. It will then re-enter the atmosphere and land. This satellite, which might be called an "orbit transport vehicle," will serve as a laboratory for studying the problems of keeping men alive in space.

Outer space might be compared to the ocean depths, since each is completely hostile to man. To explore the ocean depths, man may study the water from the surface or, with instruments, examine conditions well under the surface. With the proper equipment, he can make short journeys under the surface. But as the depth of his penetration and his periods of immersion increase, so does his need for protective equipment. To stay underwater long, man needs a completely enclosed vehicle containing food, air, and warmth.

Space is even more dangerous to man than water. He cannot stand the shortest exposure to space. Long before he leaves the atmosphere, he must start to wear protective equipment. At 63,000 feet up, atmospheric pressure is so low that body fluids vaporize, causing his blood to "boil." So a pressure suit must be worn. Loss of pressure would be instantly fatal.

There are other dangers. Cosmic rays, for example. These atomic particles, traveling at nearly the speed of light, bombard the top of our atmosphere twenty-four hours a day. The thick blanket of air around the earth protects us from these celestial "bullets."

It's estimated that our atmosphere forms a protective shield equal to a wall of lead more than a yard thick. No spaceship could carry that much shielding. Yet spaceships carrying men will have to fly through a constant barrage of cosmic rays. That's why we must first send unmanned rockets and satellites into space to find out how detrimental to life this barrage is. Some rockets and satellites have already carried animals aloft in search of the answer.

Cosmic rays and other phenomena outside the ship are only part of the problem, however. There is also the difficult problem of creating inside the ship an earthly environment in which man can live. Human life depends on an exact balance of chemicals, air pressure, humidity, warmth, food, light, and a thousand other factors — some physical, some psychological. A satellite that can return to the earth will provide the means for studying such problems.

All the problems faced by the first spacemen will be compounded by weightlessness. For when a spaceship is in orbit, centrifugal force balances the pull of gravity. Not only will the pilot feel zero gravity, but the air he breathes, the food he eats, the pencil he writes with — all will be weightless. This could be dangerous. For example, unless the air in the cabin is fully circulated by pumps or fans, the carbon dioxide the pilot exhales will hover weightlessly about him and suffocate him.

STEP 5: manned space station.

Once the problem of human survival in space has been fully studied and solved, we will be ready to tackle interplanetary travel. For this purpose we will need to build a permanent manned satellite. Without such a base of operations in space, there would be little hope of reaching another world in the foreseeable future. The reason:

To travel to the moon or to the planets, a spaceship would have to escape the earth's gravitational field. It would need a velocity of about 25,000 mph to do this. To reach this velocity, a spaceship taking off from the earth's surface would use up almost all the fuel it could carry. There wouldn't be enough fuel left for a return trip to the earth.

But using a space station as a jumping-off place is another story. The space station would be speeding around the earth at 18,000 mph or more. So any vehicle launched from it would already have that speed. It wouldn't take too much fuel to boost the spaceship's velocity to 25,000 mph. It could then escape the earth's pull and head for the moon or a planet.

The manned space station would circle the earth at a distance of hundreds of miles. Here there would be no air resistance to slow its speed. It could therefore remain in orbit indefinitely. Though the space station would not return to the earth, it would be only a short rocket-flight away.

On the station an environment similar to the earth's would have to be maintained. The station would be fully independent of outside sources of air and power. For power it would catch the unshielded rays of the sun in giant mirrors, perhaps converting the rays into electrical energy. Tanks of microscopic plants would transform the carbon dioxide that men breathe out into precious oxygen by photosynthesis. The plant could also partly supply the space station with food. Supplemental supplies of food, water, oxygen, and other items could be flown from earth.

In addition to serving as a staging area for space travel, the orbiting station would be a mecca for scientists in all fields. From it meteorologists could observe the world's weather and could learn to pinpoint weather forecasts for months in advance. Astronomers could observe the universe from outside our cloudy atmosphere. Physicians could study the effect of zero gravity on cardiac patients. And geophysicists could use the station to map the earth accurately and examine its magnetic field.

Launching of satellites is first step to planets. All models shown were prepared by National Advisory Committee for Aeronautics.

STEP 6: men to the moon.

After the space station is set up, rocket ships will be assembled on it. Their parts will be ferried up from the earth's surface.

The first destination in space will probably be the moon. It's relatively close — about 240,000 miles — and a trip to it would take only a few days. The two other most likely destinations, Mars and Venus, are many millions of miles away at their closest points to the earth. There are other reasons, too, why the moon would be the easiest to reach.

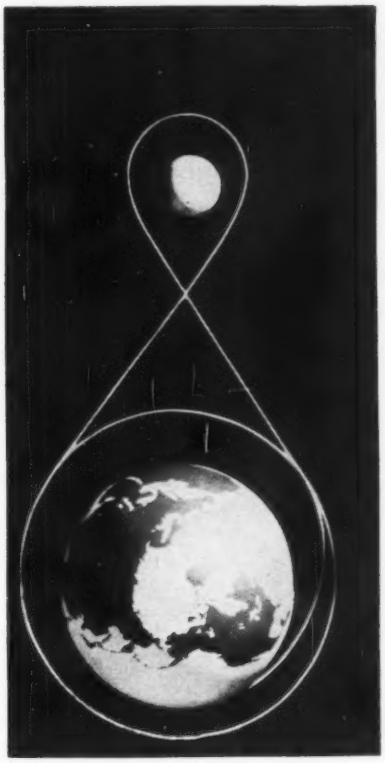
The lunar vehicles will be quite different both in appearance and in operation from today's rockets. They won't be sleekly shaped, as usually portrayed by artists. Since they will encounter no drag in airless space, there will be no need for streamlining. So their shape will be determined solely on a functional basis. Engines, cargo compartments, fuel tanks, and so forth will be positioned where they can do their jobs most efficiently.

Nor will the lunar vehicles use the chemical rocket engines of today. These engines are powerful, but waste fuel. For flights to the moon and beyond, fuel economy will be more important than power. Taking off from an orbit in space, the lunar ships will require only small nudges of thrust.

The propulsion system most frequently discussed for an interplanetary space vehicle is the ion rocket. This would work on the same basic principle as the chemical rocket.

— U.P.I.

Two moon missions to be included in step two are shown. In impact shot (*left*), rocket vehicle is launched from earth and crashes against moon's surface. In figure-eight shot (*below*), vehicle orbits earth, then is launched outward to circle moon, finally returns to orbit around earth.



The principle: a mass is fired out in one direction to develop a reaction force (thrust) in the opposite direction. In a chemical rocket the fuel burns and forces gases out of an exhaust nozzle at great speed. In an ion rocket, electricity would be used to ionize a gas. The electrified particles, or ions, thus formed would be expelled through the exhaust nozzle at much higher speeds than those possible with chemical fuels. The particles would be accelerated by methods similar to those already worked out in today's ion accelerators (such as the "Plasmatron").

Thrust from such an engine would be low, but so would fuel consumption. The engine would be able to extract more thrust per pound of fuel than would the chemical rocket.

Where will the ion rocket get its electrical power? Probably from an atomic pile carried aboard the ship. Or from the free energy beamed out by the sun.

Man may find the surface of the moon even more inhospitable than space, for several reasons. For one thing, there's a possibility that the moon's surface, lacking the protection of an atmosphere, has been made radioactive by billions of years of bombardment by cosmic rays. For another, the moon's sunny side will be extremely hot and the dark side extremely cold. In any event, man will find a dry, dead world of jagged rocks, sharp mountain ranges, dust plains, and craters. To survive, he will have to bring his own supplies of everything he will need.

But the conquest of this bleak and dismal globe will be an important scientific milestone. The moon will provide a stable platform for an observation center that should unlock many of the secrets of the universe. And the moon will be the proving ground for the rocket ships, techniques, and scientific know-how needed for the conquest of the planets.

By Gerald Wendt

An end to nuclear tests?

Though the debate goes on, scientists have laid the groundwork for an international inspection system for the detection of nuclear tests

Should nuclear weapons tests be discontinued? This is the crucial question being argued throughout the world. Recently the argument took on a new tone. It became more factual, less emotional. The people responsible for this change were the world's scientists.

The answer to the question of whether to discontinue nuclear tests hinges on the answers to two other questions:

1. How much harm does nuclear testing do? Nuclear bombs and weapons, whether large or small, cannot be improved without testing. But any nuclear weapons test sends radioactive dust into the atmosphere, where it is carried over all the world. This radioactive fall-out, it has been argued, can do great harm to the present and future health of man. So, the argument runs, it's time to stop nuclear tests. But there has been much disagreement over how dangerous the fall-out from atomic weapons actually is. And there is also the second question to consider.

2. Supposing the various countries agreed to stop nuclear tests, would it be possible for a country to conduct secret tests and gain a military advantage?

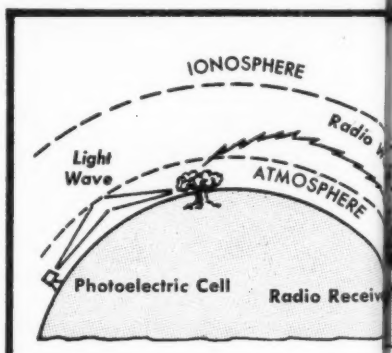
The world's scientists have now answered these two questions. As a result, the nations of the West and East are expected to start talks soon on a nuclear test ban. There are many political roadblocks in the way of an agreement. But whatever happens, everyone admits that scientists have written a new chapter in the history of international relations.

The answer to the first question — on the dangers of radioactive fall-out — came from a two-and-a-half-year study made by a United Nations committee [*see "Science in the News," September 25 issue*]. On the committee were scientists from fifteen nations. The scientists warned that "even the smallest amounts of radiation" are likely to cause harm to man. Their conclusion: "... all steps designed to minimize irradiation of human populations will act to the benefit of human health. Such steps include ... the cessation of contamination of the environment by explosions of nuclear weapons."

Though softly worded, this was an unmistakable verdict that greatly strengthened the argument against the tests. Indeed, a Russian motion before the committee had called for an immediate halt to such tests. But the motion had been defeated. Nevertheless, world opinion was aroused against the tests and against Britain and the United States, the only nations still engaged in nuclear testing.

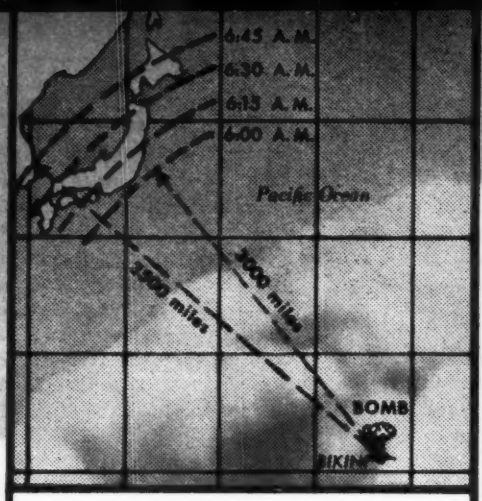
So the United States faced the second question: if we discontinue our tests, can we be sure that all other nations will do the same? The matter is too important, too dangerous, for us to put faith in mere agreements or governmental promises. These have too often been broken in the past. Is there any certain way of detecting nuclear explosions on the other side of the world? Even more important, can we be sure that if we detect none there are none?

These are scientific questions, too. And once more they have been

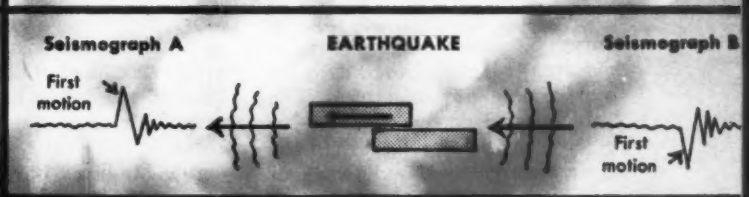


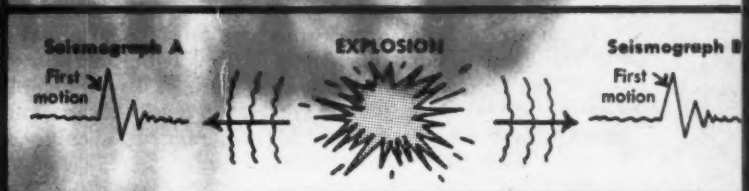
ELECTROMAGNETIC RADIATION. Explosi... sends out light and radio waves. Lig... is reflected from atmospheric laye... can be detected by photoelectric ce... Radio waves, reflected by ionosphe... can be picked up by radio.

Illustrated by Wes McKeown

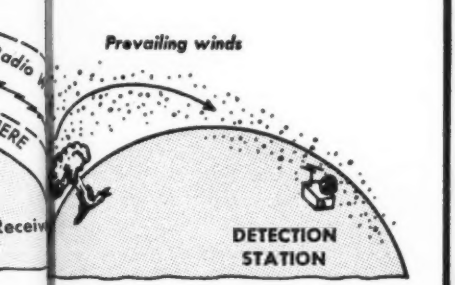


SOUND WAVES. Aerial explosion creates shock waves heard for miles. Though not audible at great distances, these waves register on sensitive microbarometers. By noting the times waves are received at various stations, location of blast can be plotted, as shown in this diagram of U. S. test at Bikini.





SEISMIC WAVES. Earth vibrations from both underground blasts and earthquakes can be picked up by seismographs. The problem: how to tell them apart. One way is shown. In earthquakes, earth movement is in only one direction. Station in opposite direction registers vibrations in reverse.



DIOACTIVITY. Nuclear blast sends radioactive particles into atmosphere. These be detected by Geiger counters. Location of test can be figured by determining of particles and direction of winds ying them.

answered by an international court of science. This one was composed of experts in the detection of radiation. They met in Geneva, Switzerland, last summer. The meeting was not set up by the United Nations, but by direct agreement between the Soviets and the Western governments. The Soviet scientists came from Russia, Poland, Czechoslovakia, and Rumania. They were headed by Professor Evgueni K. Federov, a Russian specialist on the upper atmosphere. The Western scientists — from the United States, Canada, Britain, and France — were led by Dr. James B. Fisk. An American physicist, he is vice-president of the Bell Telephone Laboratories. After exploring every possibility, the scientists agreed unanimously that a reliable system for detecting nuclear tests could be established.

Any nuclear explosion can, of course, be detected from nearby. And a really big one can be detected from almost any distance. The problem is to detect every one — large or small, near or far, in the air or underground, underwater or out in space — without fail.

There are at least four distinct methods of detection. Each is effective in its way. Three of them measure the energy released at the moment of the explosion: the air blast (or sound waves), the electromagnetic radiation (light waves and radio waves), and the shock waves that travel through the earth (seismic waves). The fourth method measures the much weaker energy emitted for long periods after the explosion by atomic fragments. These are scattered far and wide into the stratosphere by the explosion. They are then carried around the earth by winds. The scientists at Geneva studied each method:

Sound waves. An aerial explosion compresses the air around it, causing shock waves. These are easily heard as sound waves for miles. But farther away, where the human ear can no longer hear them, they still exist as faint but sharp vibrations of pressure. These vibrations can be detected by sensitive microbarometers. In this way the giant nuclear explosions at Bikini were registered in Japan, 3,000 miles away. And the Japanese were able to tell just where the bomb tests had taken place. But a smaller explosion or one much farther away could well be missed.

Electromagnetic radiation. The brilliant light from an aerial explosion can be seen hundreds of miles away. And invisible radio waves from the explosion can be detected by radio receivers a thousand miles or more away. These radio waves are reflected around the curvature of the earth by the ionized layers of the upper atmosphere. But again, as in detection by picking up sound waves, distance and the size of the explosion are important. A small explosion might not be detected from thousands of miles away, especially if it were underground or underwater.

Seismic waves. An underground or underwater test might not show up on acoustical or electromagnetic instruments. But the vibrations carried through the water and the rocks of the earth could be recorded on seismographs many thousands of miles away. These vibrations, like earthquake waves, would reveal the location of their origin. But, as before, detection by picking up seismic waves depends on the power of the explosion.

Radioactivity. The collection of radioactive dust in the air or of radioactive fall-out on the ground is probably the most reliable method of confirming an aboveground nuclear-bomb explosion. But the exact time and place of the explosion is more difficult to determine by this method. The Geneva scientists debated at length as to whether ground collection is adequate or whether samples must be collected from the air by planes. The Soviet scientists finally conceded that air-borne collection is best. But they did not say whether inspection planes would be allowed to fly over Soviet territory.

The scientists concluded that by using the four methods described, plus on-the-spot inspection of areas where blasts may have occurred, it would be technically feasible to set up a workable control system for the detection of nuclear tests. A network of 180 control posts would be set up under the direction of an international control organization.

The second scientific verdict was in. The sigh of relief was worldwide. The very next day President Eisenhower announced that the United States is ready to suspend nuclear tests for a year, as soon as an agreement can be reached by all the nuclear powers. This agreement is to be extended from year to year, provided that a reliable inspection system is set up and that "satisfactory progress" is made toward other arms control measures. Britain also agreed to suspend tests after a present series is completed in a month or two. The Soviet Union had announced last spring that it was stopping all tests. Now, the Soviet government has agreed to discuss with the West the possibility of setting up a nuclear inspection system.

Will it be possible to establish some 180 inspection stations throughout the world under international control? Will Russia permit the collection of air samples over her territory by foreign planes? Will the U.S. permit foreign (and perhaps Russian) officials to make on-the-site inspections in this country when a secret test is suspected?

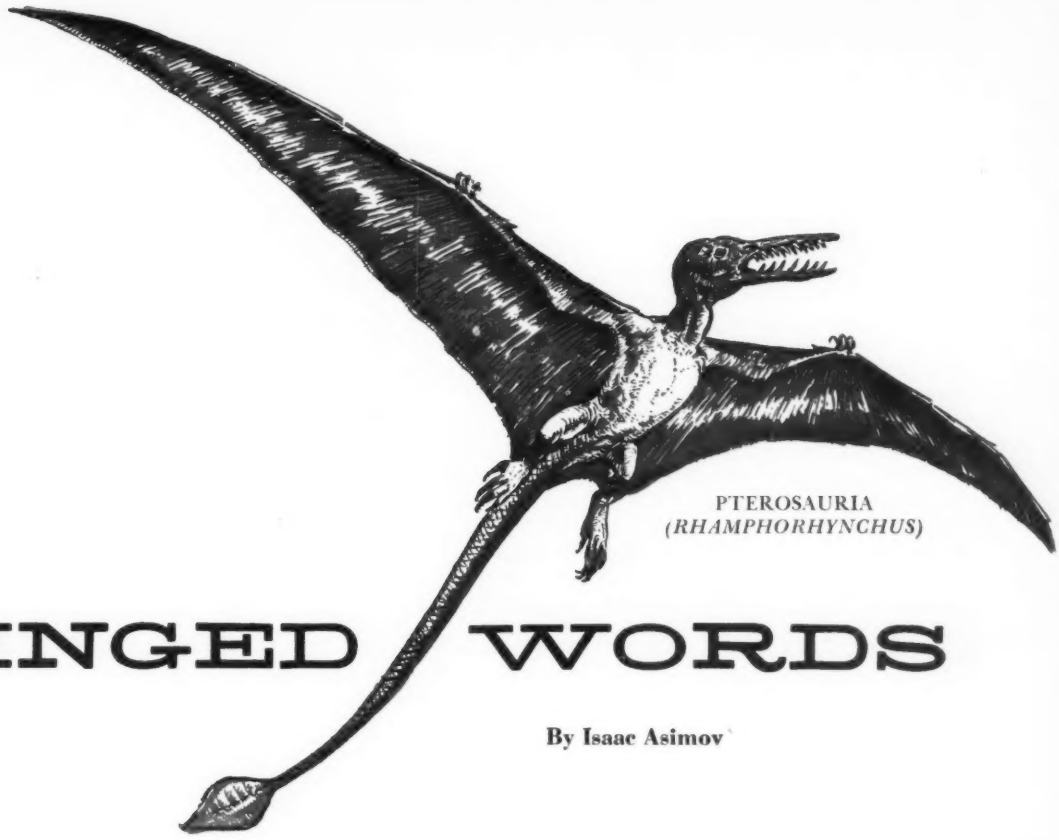
All this remains to be seen. But science has done its part in laying a firm foundation for ending the nuclear hazard.

Moon may report nuclear tests

The moon may help the U.S. detect nuclear blasts. So says Congressman James G. Fulton of Pennsylvania, a member of the House Select Committee on Astronautics and Space Exploration.

In "a great breakthrough," he reports, U.S. scientists have developed electronic equipment to make this possible. "It involves bouncing waves off the moon," he says, but "it is not radar." Apparently, the waves would in some way spot ionization created by a nuclear explosion. Ionization is the breaking-up of a neutral molecule into electrically charged particles.

Another possible use of the system: to detect instantly the launching of intercontinental ballistic missiles.



PTEROSAURIA
(RHAMPHORHYNCHUS)

WINGED WORDS

By Isaac Asimov

Of all the abilities of lower animals, mankind has surely envied most the gift of flight. Probably everyone, at one time or another, has daydreamed that he could fly like a bird, sail up over the roofs of the town, and soar lazily in the air.

This interest in wings and flying shows itself among the scientists who have classified the animal kingdom and given the various divisions and subdivisions their names in Latin and Greek. When flying creatures are involved, the classifier seems to make the Greek word *pteron* (meaning "wing") part of the name almost automatically.

The first creatures to develop flight were the insects. They are characterized by a jointed body encased in a horny covering of chitin and the possession of six jointed legs. What seems to impress classifiers most, however, is their wings.

There are some primitive insects that don't possess wings. So insects are divided into two main groups: *Pterygogenea* and *Apterygogenea*. The Greek word *genos* means "kind" or "type," and (since *pteron* means "wing") *pterygogenea* is therefore Greek for "winged type." The Greek prefix *a-* (or *an-* before vowels) always implies the negative; so *apterygogenea* means "non-winged type."

The Pterygogenea are divided into more than twenty sub-groups. And more than half of these are named for the appearance of their wings. The wings of bees and wasps (and, on occasion, ants) are two pairs of thin, flat, transparent membranes growing out of the middle segment of the body. Such insects are included in the sub-group *Hymenoptera* — or "membrane-winged" — since the Greek word *hymen* means "membrane."

Another familiar group of insects, which includes flies and mosquitoes, differs from most others in that it possesses only one pair of wings. (The second pair has now dwindled down to vestigial remnants that, by their vibration, balance the creatures in flight.) These are the *Diptera* — or "two-winged" — the Greek prefix *di-* meaning "two."

The most numerous insects of all are the beetles or "bugs." At first glance, they don't look as though they have wings at all. Their backs are covered with smooth, unbroken, glossy chitin. But startle a beetle such as a ladybird, and two curved segments of chitin lift up, a pair of wings appears from beneath, and the insect flies away. Those wings are the hind-wings. The fore-wings have been converted into a horny cover that acts as a protecting sheath. The Greek word for "sheath" is *koleos;* so the beetles are included among the *Coleoptera,* or "sheath-winged."

The most spectacular and beautiful wings in the insect world belong to the moths and butterflies. These are large wings. And they are covered with minute scales that come off as a dust when the wing is handled. These scales make the wing opaque and lend it patterns of color. The Greek word *lepis*

means "scale": moths and butterflies are therefore included among the *Lepidoptera*, or "scale-winged."

Generally, the two pairs of insect wings are not identical in appearance. In flies, the hind-wings have almost disappeared; in beetles, the fore-wings have become opaque and hard; in bees, the fore-wings are twice the size of the hind-wings. Termites are an exception, though. The two pairs of wings on termites are of about equal size and shape; so they are classified as *Isoptera* — or "equal-winged" — the Greek *isos* meaning "equal."

The insects are the only invertebrates that have developed wings and true flight. No less than three groups of vertebrates, however, have also developed wings, but in a different fashion. With the insects, none of their six legs became wings. With the various vertebrates who developed flight, though, all had only four legs; and two of these became wings.

The first vertebrates to develop wings were a group of reptiles that flourished a hundred million and more years ago and are now extinct. They include the largest winged creatures that ever lived, some kinds having a wingspread of eighteen feet. The group as a whole is the *Pterosauria* — or, since the Greek word *sauros* means "lizard" the "winged lizards."

The wings of the pterosaurs were not simply unsupported membranes as are those of insects. Instead, they were built on a framework of bone. The bones of the little finger of the fore-limbs lengthened enormously. And a membrane stretched along the finger. The other fingers remained outside the wing as little clawed digits. The creature made use of these for clinging to limbs of trees, sides of cliffs, and so on.

The giant finger which acted as wing-support is so impressive that the best-known of the pterosaurs is called a *pterodactyl* — or "wing-finger" — since the Greek word for "finger" is *daktylos*.

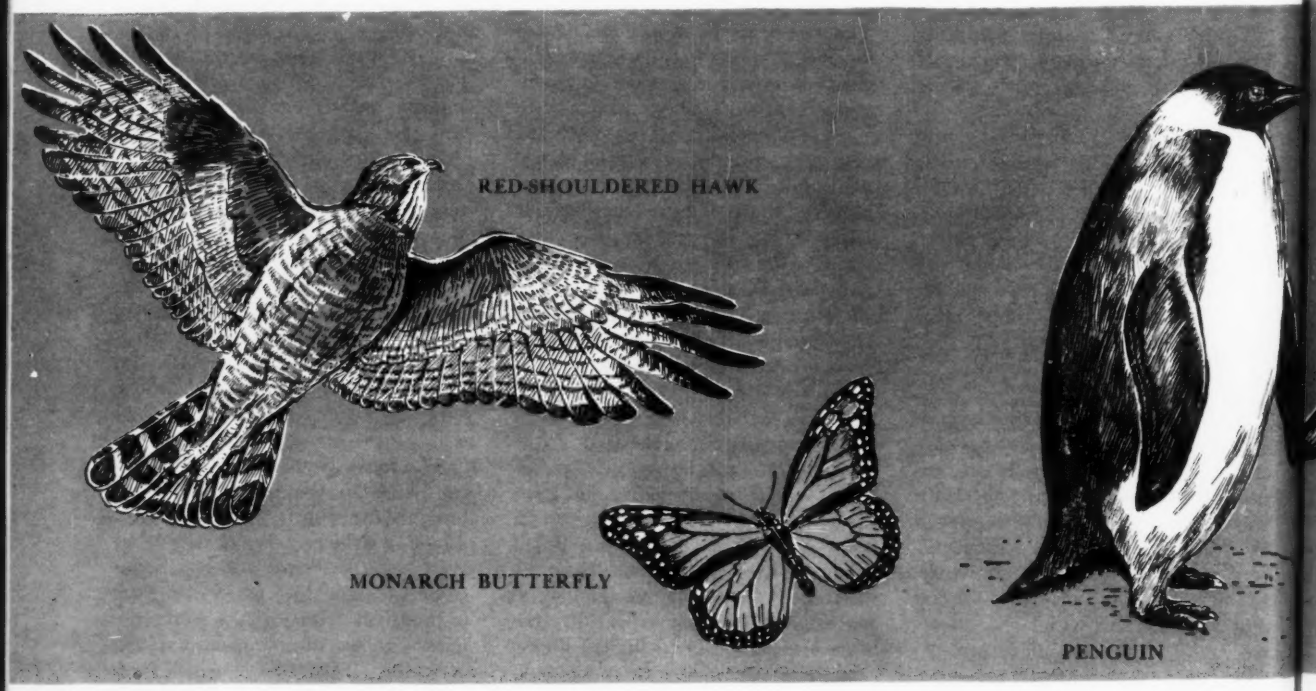
The pterodactyl possessed a tail and teeth. A larger specimen of "winged lizard" without a tail and without teeth is the *pteranodon*. This breaks down to *pter-an-odon*. The Greek *an* implies the negative and *odon* means "tooth"; so the meaning of the creature's name is "wings-but-no-teeth."

A group of present-day mammals, the bats, have also developed wings. Their wings consist of a membrane stretched across fingers. However, while in the pterosaurs the bones of only one finger acted as stiffeners, in the bats four fingers are involved. The wing membrane stretches from one to the other of the enormously lengthened fingers (with only a tiny thumb remaining outside), giving the wings a unique scalloped effect.

A bat, then, is no "wing-finger," but rather a "wing-hand." This is reflected in the scientific name of the group to which bats belong. The name is *Chiroptera* — or "hand-winged" — the Greek word *cheiros* meaning "hand."

By all odds the most familiar and noteworthy of the winged creatures are the birds. The mark that distinguishes birds from all other creatures is feathers. These are an adaptation (like the hair of mammals) of the reptilian scale. The bird wing is not a naked membrane

BIRDS, INSECTS, MAMMALS, EVEN FERNS, are linked as winged by classifiers of science. Key to the classification is Greek



like the wings of insects, bats, and (probably) pterosaurs, but is covered with these feathers. The stiffening of bird wings consists not of one finger or even of four fingers, but of the entire fore-limb with all the finger bones fused together.

Few of the scientific names of the groups and sub-groups of birds involve the Greek *pteron*. Perhaps this is because wings are taken for granted in the case of birds and don't seem to call for remark. Yet there are some exceptions, too.

The most ancient known bird, for instance, is a creature (long extinct) that lived perhaps in the time of the pterosaurs. It is known only in fossil form. It had a long lizard-like neck, and it possessed teeth. Even so, it is considered a bird because it had feathers — their imprint was left on the rock. This half-reptile, half-bird is called *Archaeopteryx*. The Greek word *arche* means "beginning," so the whole name means "the beginning of wings." (And so it is as far as birds are concerned, though insects had wings many millions of years before that.) The really startling thing in a bird is the absence — or near absence — of wings.

These are flightless birds like the ostrich, whose tiny wings are too small to lift its giant body, or the penguin, whose wings have become sea-going oars. Still, even in such birds, the wings are there.

There's a New Zealand bird, however, whose wings are almost entirely missing. Usually called the kiwi (in imitation of the soft sound it makes), it is also called *Apteryx*, or "no-wings."

You might not suppose that the word *pteron* could find application to plants, since there are none with the capacity of true flight. (Naturally, seeds blowing through air or drifting with the wind don't count.)

Nevertheless, wings do show up, by way of a detour. The most familiar flying creatures, you see, are birds, and the most characteristic thing about birds are feathers. Feathers have therefore come to be so closely associated with wings as scarcely to need a separate word. So the Greek word for "feather" is also *pteron*.

There is one group of plants, the ferns, which have organs called fronds. Fronds have leaflike extensions delicately subdivided along a central stem so that they look like green feathers. And the Greek word for "fern," *pteris*, may derive from the Greek *pteron*.

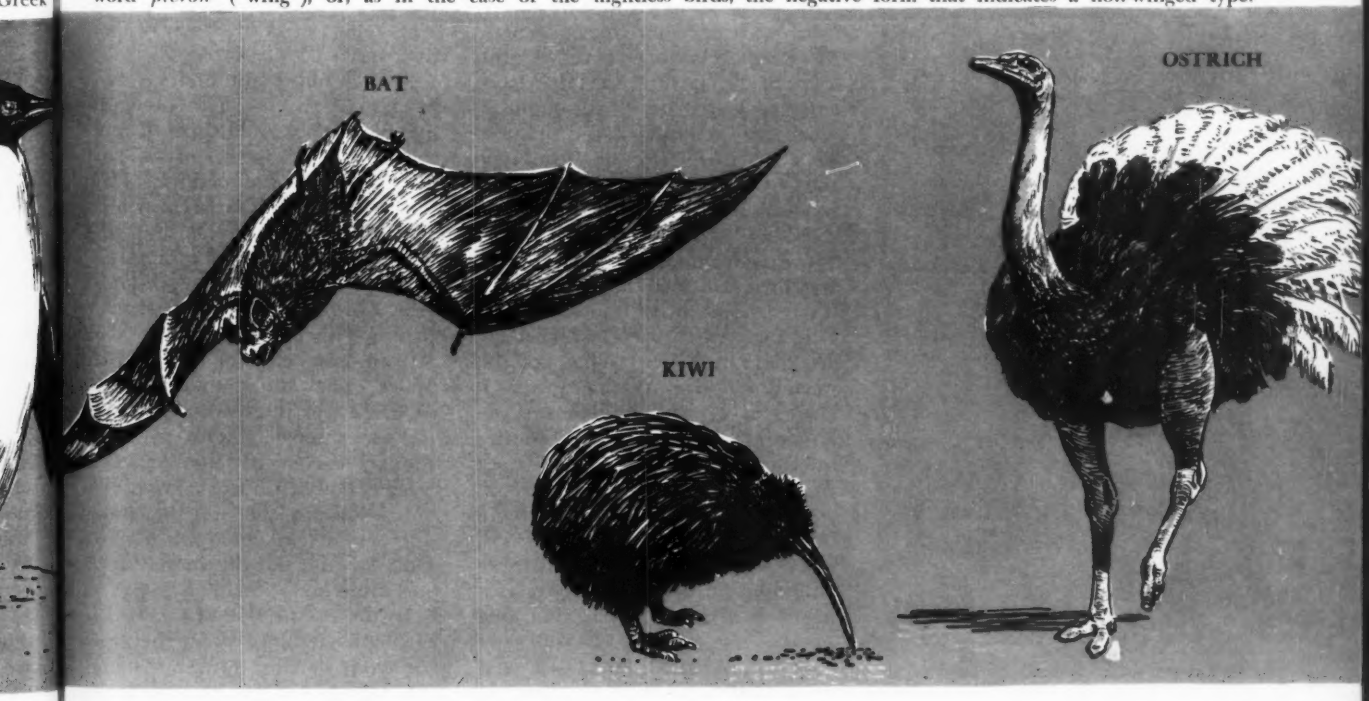
The scientific name for the group of plants to which ferns belong is *Pteridophyta* — or "feather-plants" — since the Greek *phyton* means "plant."

Nor is the inanimate world neglected. The structure of the chemical compounds that give the color to butterfly wings was worked out in the early 1940's. These were given the name *pteridines* from the last letters of *Lepidoptera* (the group including moths and butterflies).

One of the B vitamins essential to all life has a structure in part similar to these. It is called *pteroylglutamic* acid. So, you see, the game of tracing the meaning of scientific words can have all the excitement of the unexpected. You start with insects and end with vitamins, or you start with birds and end with ferns.

Illustrated by Matthew Kalmenoff

word *pteron* ("wing"), or, as in the case of the flightless birds, the negative form that indicates a non-winged type.



By Fredric C. Appel

Progress report on IGY

Rivers beneath the sea, ice two miles thick, mysterious heat from the ocean floor — these are a few of the discoveries to date

— Woods Hole Oceanographic Institution

SPRAY-SPLASHED oceanographer lowers Nansen bottle for water sample.

Flowing deep in the ocean between South America and Asia is a river that carries more than a thousand times as much water as the Mississippi; ice in the antarctic is more than 10,000 feet thick in some places; a new range of mountains is rising from the bottom of the Pacific Ocean. These are just a few of the startling facts that have emerged in the last fifteen months. They are a result of the greatest research project in the history of the world — the International Geophysical Year.

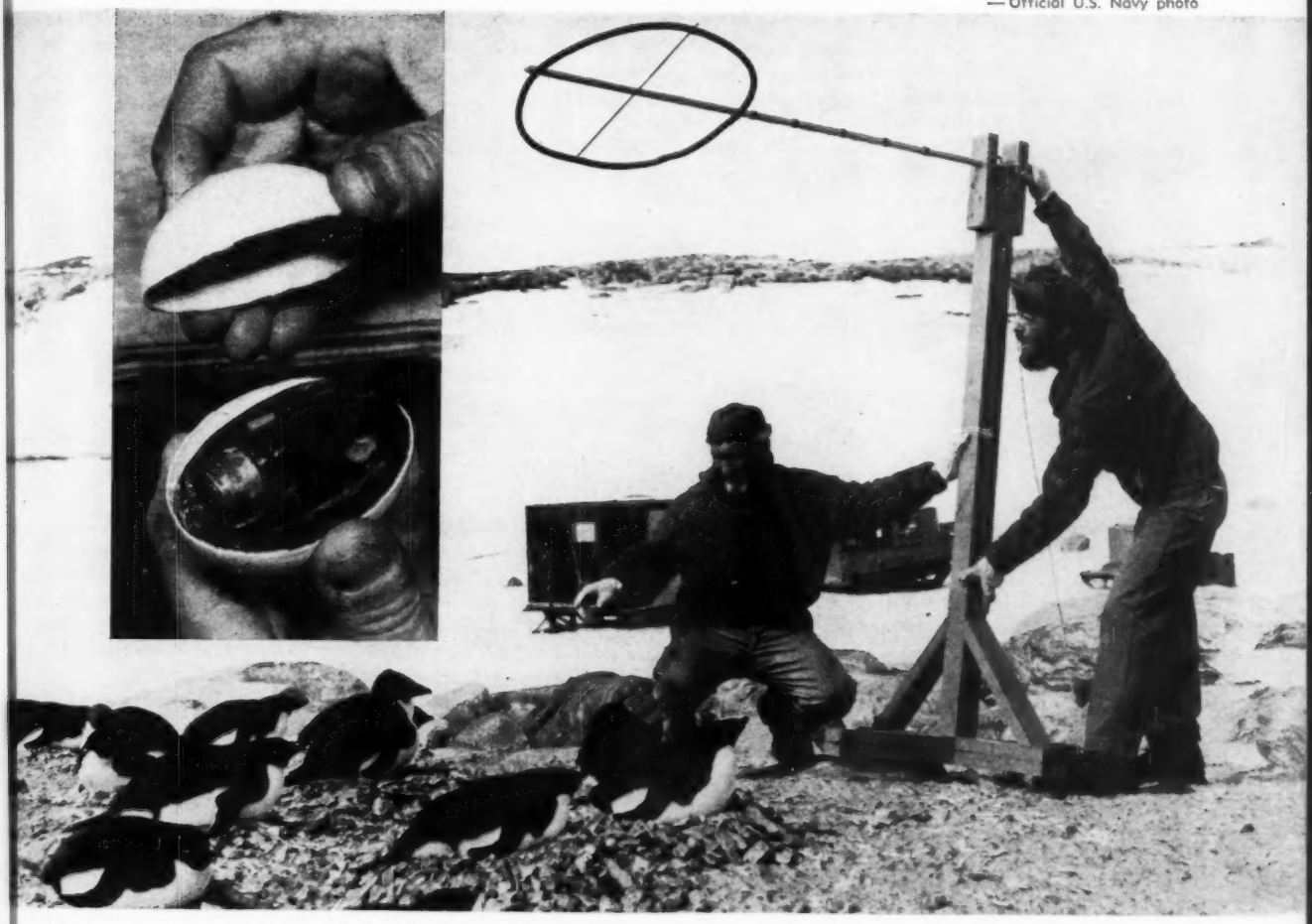
Today the idea of space travel is a common topic in conversation. But men still have a great deal to learn about their home planet. How high is the sky? How far apart are the continents? What are the northern lights? During IGY, scientists are trying to discover the answers to these and a host of other questions. Since July, 1957, more than 10,000 scientists from 66 countries have been working in the more than 2,500 IGY observing stations.

The full value of IGY will probably not be realized for at least twenty years. It will take that long for the vast quantity of data gathered to be sorted, processed, and distributed to the world's scientists. Only then will they be able to relate the material to other known facts and produce a more complete picture of our planet. But many of the discoveries made are already having profound effects on some of the most basic theories of science. This report describes a few of these discoveries.

Several important findings have been made in the field of oceanography. Aboard 90 ships of more than 30 nations, scientists have been cruising the oceans. Their purpose: to study currents, tides, underwater topography, the temperature and chemical composition of the water at various depths. Last year, two research ships made a surprising discovery in the Gulf Stream just east of the United States. They found that at depths of 6,500 feet there was practically no water movement at all, even though the swiftly moving Gulf Stream flowed directly above. But going down to 9,000 feet they found another current, equal in size to the Gulf Stream, flowing in the opposite direction!

In the Pacific, a well known surface current flows along the equator from Panama toward Asia. A few months ago, IGY research ves-

— Official U.S. Navy photo



MOVING RADIO ANTENNA close to egg-sitting penguins, Carl Eklund and Frederick E. Charlton study how warm a penguin keeps its eggs during antarctic winters. Radio thermometer previously placed inside eggs (*inset*) broadcasts temperature.

sels came upon an underwater current flowing beneath it. Again, the two currents flowed in opposite directions. The equatorial undercurrent is particularly astounding because of its size: it carries about a thousand times as much water as the Mississippi.

Currents have not been the only big news in the oceans. Trenches —deep ones—are also in the news. Oceanographers have discovered trenches in the Pacific ranging in depth from 25,000 to 35,000 feet. The four deepest are all within 600 feet of the same depth: 35,000 feet. This has led to an interesting speculation. Dr. Roger R. Revelle of the United States IGY oceanography committee recently told Congressmen, "It looks as though there must be some reason for this: that this is the deepest hole that you can dig in the ground; that you cannot exceed 35,000 feet without the sides caving in."

Oceanographers have also discovered several new tides. We are familiar with 12-hour, 24-hour, and 2-week tides. But tides that occur annually, every 14 months, and every 18 years have also been shown to exist. The 14-month tide is caused by a peculiar phenomenon of the earth's rotation. Over a 14-month period, the earth wobbles, or shifts, on its axis by about 30 feet. This wobbling shifts the water in the oceans, causing the 14-month tide.

A research expedition by the Scripps Institution of Oceanography made two interesting discoveries in the southeast Pacific. Right down the middle of the ocean floor is a great ridge called the Albatross Plateau. From a narrow region along the spine of the ridge, heat from the center of the earth has been escaping at the rate of 300 calories per square centimeter per year. This is more than seven times the normal rate of heat flow (40 calories) from the ocean floor. Scientists believe the excess heat indicates great activity under the earth's crust at that point. They believe the interior of the earth is pushing up a new mountain range through the ocean floor.

Scripps oceanographers have also measured heat flow in a deep trench off South America. There they

found the very low rate of 10 calories per centimeter. Fossils taken from the trench show that the land was once above sea level and has been sinking for the past twenty to thirty million years. It is believed that as the mountain range of the Albatross Plateau is being pushed up, the South American trench is being pulled down at the same rate, as if by some giant in the center of the earth.

On the same expedition, the oceanographers made a valuable mineral strike. They found that millions of square miles of the southeast Pacific's ocean floor are covered with loose nodules of manganese, copper, iron, nickel, and cobalt. The discovery here of nickel and cobalt has special significance, since both are scarce in the United States. Experts working at the College of Mining in Berkeley, California, have estimated that some $500,000 worth of metal could be brought up from each square mile of the sea bottom in this one area.

The greatest geographic concentration of IGY research is in Antarctica. Twelve countries have built some 50 scientific stations on the coast and in the interior. Hundreds of scientists are braving the antarctic elements to study the continent, its weather, and the relationship between this weather and that of the rest of the world.

One large area of antarctic research is the investigation of the continent's structure. Antarctica is covered by a great ice cap. So facts about the land beneath are being gathered by gravity measurements and by seismic soundings to determine ice thickness. In sounding, scientists send sound waves down through the ice. Then they measure the length of time the waves take to bounce back up from the bedrock below. Ice thicknesses of 14,000 feet have been recorded.

A great frozen inland sea has been discovered in Marie Byrd Land. In the same vicinity a great trough has also been found. This may connect with the inland sea and may mean that the continent consists of several land masses instead of one big solid one.

There also may be an unfrozen body of water somewhere in the interior of Antarctica. Scientists began to speculate about this after finding fresh penguin tracks more than 150 miles inland. Penguins are not believed to stray far from water.

Meteorologists have been studying antarctic weather to determine its effects on the world's weather. Glaciologists have been probing past climate. They've been boring down through the ice and taking the temperatures of layers laid down thousands of years ago.

World's coldest spot

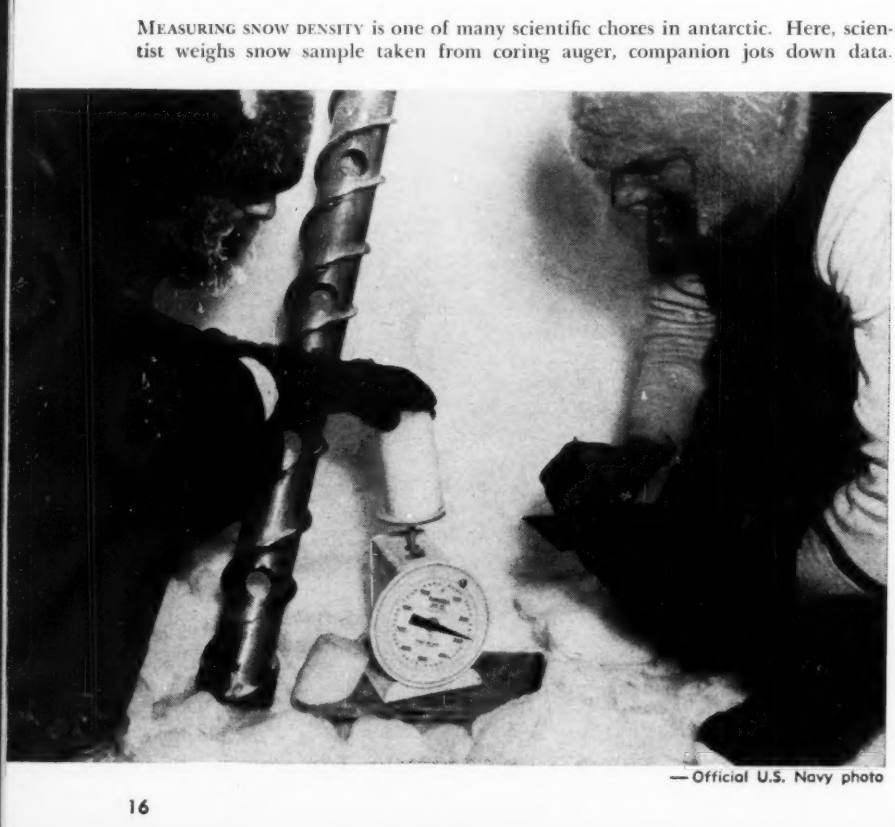
The antarctic earned the title of the coldest place in the world when the thermometer at the American South Pole Station dropped to minus 102.1°F. The lowest temperature recorded before this had been minus 90° F. in Siberia. The American station record has now been broken twice. The Russian antarctic station Sovietskaya, 13,000 feet above sea level, recorded a minus 110° F. last April, a minus 114° F. in July.

The extreme cold of the antarctic is of special interest to oceanographers. It causes some 2 per cent of the earth's water to be locked up in the polar ice cap. They estimate that if this cap were ever to melt, the level of the oceans would rise by between 200 and 300 feet. A slight warming of the antarctic climate over the past fifty years has been detected. But this slight rise in temperature is not enough to melt the ice. In fact, it will increase the size of the ice cap by allowing more snow to fall. Such an increase will lower the level of the oceans.

Scientists in the antarctic are also studying aurora and airglow, cosmic rays, and ionospheric physics. The results of all this research, however, will not be available for a number of years. It's not hard to understand why. For the amount of material being gathered here, as elsewhere, is fantastic. Last March, for example, a shipment of scientific data was sent from the antarctic to the United States. Its weight: over ten tons.

[*Coming soon: IGY explorations of the sun and space.*]

MEASURING SNOW DENSITY is one of many scientific chores in antarctic. Here, scientist weighs snow sample taken from coring auger, companion jots down data.



— Official U.S. Navy photo

Science in the news

Sun to go on rampage during eclipse

Astronomers and other IGY scientists have a special interest in Columbus Day this year. That's the day – October 12 – a total solar eclipse is expected to occur. As seen from one area in the South Pacific, the sun will be completely covered by the moon for five minutes and twelve seconds.

This solar eclipse is considered to be of major scientific importance. The sun's corona – its faintly glowing outer atmosphere – becomes visible during a total eclipse and can be studied as it can at no other time. The corona changes as the level of the sun's activity changes. This eclipse will occur during a period of peak activity, with marked solar eruptions. (Indeed, the International Geophysical Year was scheduled to coincide with intense solar activity.)

These eruptions have observable effects on earth. The effects include cosmic-ray storms, auroral displays, bursts of radio noise coming from the sun, disturbances in the ionosphere (electrically charged air beginning about 25 miles above the earth), magnetic fluctuations, and disturbances in radio communications.

The most-observed eclipse of all time occurred in January, 1952. It came when the sun's activity was near its minimum. Records of the two eclipses will be compared to determine what happens at and above the surface of the sun during periods of maximum and minimum activity.

UN space organization proposed by U.S.

The U.S. has proposed that a new space organization be set up by the UN. Purpose: to make space exploration an instrument for peaceful progress. Individual nations would co-operate in the exploration of space.

Space exploration could become an instrument of military destruction. For instance, a fleet of reconnaissance satellites could be used to study the world's weather – or to spy on enemy territory. Satellites could also be used to transmit television programs across the earth – or they could be used to relay military communications.

Many scientists view the U.S. proposal as a logical step toward the peaceful use of space.

—General Motors Corp.

Single control stick in this seven-finned experimental car, Firebird III, takes place of steering wheel, brake pedal, accelerator. Car is powered by gas turbine.

Atomic secrets shared by world's scientists

Scientists of 67 countries met last month to discuss peaceful uses of atomic energy. Their meeting place was Geneva, Switzerland. Only a short time before, other scientists had met there to discuss ending nuclear weapons tests. (See page 8 of this issue.) At the second meeting, scientists again showed that they could cut across national differences and work together.

The meeting was the UN's Second International Conference on the Peaceful Uses of Atomic Energy. As a result of the first such conference in 1955, scientists from the various countries started to share atomic information. But controlled thermonuclear research continued to be a closely guarded secret. At the second conference, the scientists broke down this last barrier of atomic secrecy. And, surprisingly enough, they found that thermonuclear research was proceeding along the same lines from country to country.

When man learns to control a thermonuclear reaction – thereby harnessing the power of the hydrogen bomb – the world will have an inexpensive and inexhaustible source of power. But, the scientists concluded, it may be many years before this can be accomplished successfully.

More than two thousand papers at the conference set forth progress made in other areas of atomic energy. Some highlights:

- Great strides have been made in producing power from atomic reactors. By the mid-1960's, nuclear power should become economical.
- Scientists are making headway on the key problem of disposing of dangerous radioactive wastes. One of the most promising methods is to enclose them in insoluble glass that could easily be stored.
- Radioactive isotopes are providing the nuclear age's first real benefit to all mankind. These isotopes shoot tiny particles from themselves. The trail of particles can be traced by a Geiger counter. Isotopes can be used for a variety of purposes. In industry, for example, they can be put into crude oil. Engineers can then follow the oil through the various refining steps and improve on refining techniques. Meteorologists can use isotopes to trace air masses and clouds high above the earth, thereby improving weather forecasting. Doctors can use them to follow various body processes. Radioactive isotopes even show promise in law enforcement. Paper money could be marked with a minute, harmless quantity of an isotope. Special equipment could then easily spot counterfeit bills because they would lack the radioactivity of real money.

Digging scientists find old city, 'death ships'

Digging in far-flung Borneo and Turkey, archaeologists have made two important finds. These finds may help fill in some of the blank pages in the history of mankind.

In Sarawak, Borneo, archaeologists discovered a series of caves. These proved to be the dwelling places of countless generations of ancient man. The Borneo caves contained skeletons, pottery and tools of stone and metal. The archaeologists also found "death ships" built to take ancient man on funeral journeys to another world. Surrounding the wooden ships were skeletons of the original occupants. Elaborately carved with figures of tiger-dragons, the ships were just long enough to hold the body of a man. The scientists hope that further digging may uncover some of the missing links in the development of man.

In Turkey, archaeologists unearthed the ruins of ancient Sardis. This was the capital city of Lydia, an important kingdom in the sixth century before Christ. A study of the ruins may tell us to what extent Lydian culture influenced our Western civilization.

Powerful gas can help fire bigger satellites

Scientists have known for some time that the gas fluorine could really boost the power of rockets. Used in current rocket engines, it would enable the United States to launch satellites heavier than Russia's Sputnik III (weight: 1½ tons). But the handling and storing of fluorine posed a terrific problem. Fluorine is so active chemically that it can ignite asbestos, leather, and even water on contact.

This problem has now been solved by engineers at Bell Aircraft Corporation, working with the Air Force. They have developed containers of specially treated metals in which fluorine can safely be kept.

Fluorine is the most powerful oxidizer known. A rocket must carry an oxidizer to make its fuel burn in airless space. The oxidizer carried in today's rockets is pure oxygen that has been liquefied (to take up as little room as possible). Fluorine, which would also have to be liquefied, is a more powerful oxidizer than oxygen. It can combine with a fuel to produce more heat and energy than oxygen can. The more heat and energy produced by a fuel and oxidizer, the more push a rocket receives.

Liquid oxygen and kerosene form the combination most often used in current rockets. They can produce a specific impulse (push measured by the burning of one pound of fuel per second) of 245 pounds. But the use of liquid fluorine instead of oxygen can increase specific impulse to as much as 345 pounds. As a result, the weight of the payload (final stage of a missile or rocket) can be increased up to 70 per cent. Or the same payload can be carried by a smaller, lighter vehicle.

New weather term coined — 'discomfort index'

The "discomfort index," a new term in that favorite topic of conversation — the weather — has come into being. D.I., as it is called, is an improved way of measuring the degree of human unhappiness caused by the combination of heat and humidity.

The formula for the discomfort index is: D.I. = 0.4 (Td + Tw) + 15. In figuring it, you add the "dry bulb" temperature (Td) shown on your thermometer to the "wet bulb" temperature (Tw). To determine the wet bulb temperature, you wind a piece of wet muslin around the bulb of a thermometer, swing the thermometer around a bit, then read the temperature. Multiply the sum of the dry and wet bulb temperatures by 0.4, and then add 15. Your answer: the discomfort index.

At a given temperature, the higher the humidity (the amount of dampness in the air) the higher the discomfort-index reading. This is so because the rate of evaporation — a cooling process — is slowed by the degree of dampness in the air.

Weather experts admit that their formula still isn't perfect. But they have decided that the average person's "comfort zone" is threatened when the D.I. hits 70.

Space dogs return safely to earth — man next?

Now that Russia has announced the safe return of two space-traveling dogs, the question arises: when will the U.S.S.R. send a man into space? That question can't be answered, of course. But it's said that the Russians are concentrating on the problem of launching a man-carrying satellite. As for U.S. plans along this line, our rocket experts say we will launch a manned satellite by 1963, possibly sooner.

Many problems must be solved by U.S. space experts before they can safely put a man into orbit. They must know, for example, whether a man can pass without harm through the band of intense radiation recently reported by U.S. Explorer satellites. Another problem is that of returning a man to the earth.

Pestraya and Belyanka, Russia's space dogs, were rocketed 281 miles up. They were returned to earth by parachute. A special air-braking device slowed their rocket's descent so that the cabin carrying the dogs could be released. But the braking process, says a Russian scientist, is "particularly trying" to any living creature.

Looking beyond manned satellites, scientists feel sure that man can be trained to withstand the physical rigors of journeys into space. But they wonder how he will react mentally. How will he be affected by changes in sleep habits, long periods of loneliness, or times of great emotional stress, as he's hurtling through space? To help find out, U.S. Army volunteers will be outfitted with diving gear and submerged in a special swimming pool for several days. While submerged, they'll be given questions to answer and problems to solve. Their heartbeats, breathing, reflexes, and general behavior will be checked and rechecked.

Birds guided by stars on nighttime flights

Why don't birds get lost on their long migratory flights? Scientists have puzzled over this question for many years. Now they're beginning to fill in the blanks.

A few years ago, experiments showed that birds rely on the sun to guide them during daylight hours. But what about birds that fly mainly at night? Tests with artificial stars have proved conclusively that certain night-flying birds are able to follow the stars in their long-distance flights.

One such bird — a warbler — had spent its lifetime in a cage and had never flown under a natural sky. Yet it showed an inborn ability to use the stars for guidance. The bird's cage was placed under an artificial star-filled sky at migration time. The bird tried to fly in the same direction as that taken by his outdoor cousins. Any change in the position of the make-believe stars caused a change in the direction of his flight.

Scientists think that warblers, when flying in daylight, use the sun for guidance. But the stars are apparently their principal means of navigation. What do they do when the stars are hidden by clouds? Apparently, they find their way by such landmarks as mountain ranges, coastlines, and river courses. But when it's too dark to see these, the warblers circle helplessly, unable to get their bearings.

Nature full of surprises in cold, cold world

The strange nature of a frigid new world is being explored by scientists at Bell Telephone Laboratories. This "world" exists near the utter limit of extreme cold: absolute zero (minus 459.6° Fahrenheit), which represents the complete absence of heat.

Scientists can no more produce absolute zero than they can a perfect vacuum. But as they come closer and closer to it, they can better understand the curious ways of this frigid world. In it, ordinary laws of nature are repealed and new ones enacted in their place:

For instance, within 10 degrees of absolute zero, pure metals conduct high-frequency sound waves up to 1,000 times better than they do at room temperature.

Normally, most metals are considered good conductors of sound energy. But they do offer some resistance to sound. This resistance increases as a metal is cooled through the normal ranges of temperature.

Yet, within a few degrees of absolute zero, it was discovered that this resistance dropped -- abruptly and rapidly. And as the coldest temperatures were reached, the metal seemed to present high-frequency sonic waves with a six-lane expressway, downhill all the way.

On top of this, it was discovered that the introduction of a strong magnetic field could increase even more the capacity of some metals to carry the sonic energy. Thus, a direct link between sound and magnetism has now been established.

Another discovery concerned electrical conductivity. An electric current, induced in a continuous wire kept at a temperature near absolute zero, will continue running around the wire for years. Because of this phenomenon, the frigid condition is called the state of superconductivity.

The nearer Bell Lab physicists get to absolute zero, the more noticeable become the curious properties of the frigid world. The more clearly they can isolate the unusual effects, the greater chance they have of understanding not only the frigid world but the atom itself. Their research is expected to point the way toward new devices to improve telephone service through high-frequency electronic amplifiers.

—Bell Telephone Labs

BELL LABS TECHNICIAN loads equipment with liquid nitrogen before experiment calling for a temperature near absolute zero. When extreme cold is produced, metal will conduct ultra-high-frequency sound waves up to 1,000 times better than it will at room temperature. Absolute zero is 459.6 Fahrenheit degrees below zero.

News in brief

● Explorer V's failure to orbit was caused by a collision between the parts of its launching rocket, say missile experts. After the first-stage booster rocket had separated from the rest of the four-stage vehicle, liquids and gases remaining in it expanded. This gave it an extra boost in speed. This rocket collided with the instrument part of the vehicle and knocked it off course. So the remaining three stages did not carry the satellite into an orbit.

● Is the housefly a dangerous disease carrier? Surprisingly enough, scientists say no. Flies, researchers find, have a peculiar ability to shed harmful bacteria picked up in garbage and other refuse. For this reason, they are not dangerous carriers.

● Moon-Shot II, scheduled for mid-September, was postponed by the Air Force. Reason for the change of plans was not given. But officials said privately that an adequate launching vehicle had not been readied. The moon will be close enough to the earth for another shot in mid-October.

● Three baby whooping cranes made their debut in northwest Canada. They were spotted in the breeding grounds set up for the nearly extinct birds. The new arrivals bring the total known population of whooping cranes to thirty-five.

● Scientists suggest developing a vacuum-cleaning satellite. These "sweeper" satellites could help clean up the dangerous band of radiation in the atmosphere that threatens man's entry into space. The band begins at about 600 miles above the earth.

● Are you one of the millions of Americans who haven't had polio shots? Figures compiled by the National Foundation, as of August 1, reveal that 44 million persons under 40 (the years when danger is greatest) have failed to make use of the vaccine. Thousands of these, says the Foundation, have escaped the crippling disease only through sheer luck.

● If and when he gets there, man may be able to set up housekeeping on the moon. Scientists at Westinghouse Corporation say they've developed a power plant that can utilize the sun's rays. Through an electric voltage process, the plant uses the sun's rays to produce water, fuel, oxygen, and other materials needed for man to survive on the dead satellite.

Explorers of the body

A camel in an oasis of the Sahara Desert . . . a seal in the waters off Bar Harbor, Maine . . . a kangaroo rat in the Arizona desert . . .

These three animals have figured prominently in the research project of Dr. Bodil Schmidt-Nielsen. A Danish-born woman scientist, Dr. Schmidt-Nielsen was awarded a five-year research grant by the American Heart Association. Her objective: to determine to what extent and why the kidneys are involved in one type of human heart failure.

The body's two kidneys, as we know, act as waste-disposal units. So why study *them*, when the problem is heart trouble? The reason, as Dr. Schmidt-Nielsen explains it, is this: her special interest is congestive heart failure. In this disease, the heart apparently does not pump enough blood to all parts of the body. Oxygen carried by the blood is therefore in short supply. This upsets the body cells. As a result, excess fluids accumulate in them. They swell. The swelling shows up in the ankles, the liver, the veins, and other parts of the body. This causes shortness of breath and, sometimes, death. The kidney's normal function, Dr. Schmidt-Nielsen points out, is to rid the body of excess fluids. Why doesn't it do so in congestive heart failure?

She doesn't know the answer yet. But her investigation has led her down some interesting paths. And it has given her — and the medical profession — some unexpected insights.

She has found, for example, that an animal kidney appears to have a special filter. This regulates the amount of urea the kidney passes back to the blood and the amount it passes off in urine. (Urea is a nitrogen compound left when the body breaks down food proteins. It and water are the main substances in urine.) Up to now, researchers have thought that urea merely seeped, more or less by chance, back into the blood. If definitely proved, Dr. Schmidt-Nielsen's theory would represent a major change in medical knowledge about the kidney. It might also affect the diagnosis and treatment of certain kidney diseases.

Her studies of the camel and kangaroo rat first led Dr. Schmidt-Nielsen to suspect the presence of a urea-regulator in animal kidneys. She was intrigued by the kangaroo rat's ability to live without any moisture other than that in its food. It probably needs less water than any mammal on earth. During her study, she learned that the urea passed off by the rodent's kidneys varies according to its diet.

Then, on a trip to the Sahara Research Center in southern Algeria, she studied the camel. Her finding: diet also affected the amount of urea a camel's kidneys discharged as waste. On a low-protein diet, the camel retained much more urea. This "salvaged" urea, she eventually found, was returned to the camel's first stomach (or rumen) by the blood. There the urea was converted into a synthetic protein — which the camel badly needed.

Dr. Schmidt-Nielsen's research led her to sheep, then to dogs, and finally to man. Human kidneys, she discovered, also seem to be able to regulate urea. But they do much less regulating than most animal kidneys. The human body can turn urea into a synthetic protein, too. But, unlike the camel, it needs help from outside the body to complete the synthesis. The help comes from amino acids found in the proteins we eat.

Seals — and their kidneys, of course — now occupy the major part of Dr. Schmidt-Nielsen's attention. From them, she hopes to gain new clues about what happens inside the human kidney. Her research is a big step toward the conquering of kidney diseases and congestive heart failure.

If Dr. Schmidt-Nielsen *hadn't* become a scientist, it would have been surprising. Her father, the late Professor August Krogh, was a Nobel Prize winner in medical physiology. His special field was the regulating of capillary blood supply in muscle tissue. Her mother, Marie Jorenson Krogh, is a physician. She assisted her husband in his Nobel Prize-winning research.

Research headquarters — and home — for Dr. Schmidt-Nielsen is Duke University in Durham, North Carolina. Her husband is a professor of physiology there. And how does she spend her free time? Better just say she has three children — aged 15, 13, and 9.

What makes the heart beat? Why are some babies born imperfect? What makes some cells suddenly go haywire and become cancerous? What makes the blood clot? *We don't know.* The answers will have to be found by medical researchers of the future.

Medical research is concerned with every part and function of the human body. It needs a great variety of trained people — not only physicians and biologists, but also chemists, physicists, statisticians, and electrical engineers. The medical researcher must be supremely competent, energetic, and imaginative. And he must be willing to dedicate himself to using his scientific knowledge for the betterment of man.

It's true that a medical researcher may have to limit himself to the study

— American Heart Assn.

SLIPPERY SEAL IS STUDIED by Dr. Schmidt-Nielsen and fellow scientist to learn more about one type of human heart failure.

of a special, "narrow" field. But by so doing, he has a better chance of making a far-reaching, lifesaving discovery. His contribution to human welfare can be every bit as important as that of a great statesman or educator.

The following questions and answers may help you decide whether medical research offers a career possibility for you.

What natural interests and abilities should you have?

A medical researcher's mind must be a blend of persistent curiosity, logic, and imagination. And he must have the intellectual stamina to think a problem through. Half-thought-out or unfounded theories don't count for much in research. Your ability to work out and complete a science project would be a clue to how you might do in research work. But you must begin to decide, even now, whether you want to dedicate yourself to seeking the causes of and cures for human sickness.

Is there any way of telling now whether you would like the work?

There is no better way to decide than by setting up your own research project. If you're stumped for a project idea, your science teacher or school science club can probably give you some. You can also get help by talking with druggists, physicians, dentists, and scientists in local industries. They will usually be glad to talk over your projects and offer what help they can. Also, read as widely as you can in the sciences. Many stimulating books can be found in inexpensive paperbound editions.

What will you take in college?

In your first two years, you'll probably take basic courses in biology, chemistry, physics, and math. Then, in your junior year, you will choose a definite field and concentrate more and more on it. (Of course, you'll also want to take non-science courses — foreign languages, literature, history, philosophy, art. These give a scientist perspective and enable him to evaluate his work in human terms.) Summer vacations can be valuable to potential researchers. For example, local and state American Heart Associations provide summer research grants for undergraduates. There are many other research opportunities, some of them on a paid basis.

Should you do post-graduate work?

It's absolutely necessary — either as a candidate for a Ph.D. or D.Sci. degree at a graduate school or as a candidate for an M.D. degree at a medical school. Only after three or four years of graduate study will you be prepared for a research career.

What about women in research?

If a woman proves she is capable of doing first-rate, creative research in a given field, she is as welcome as a man.

What happens after graduate school?

Unlike most careers, there is usually no sharp break between the end of your studies and the beginning of your life's work. You will already have experienced the methods and routines you will be using, absorbed most of the guiding principles, and set your sights on possible goals. You may even stay on at the university where you did your graduate study. But you will gradually take more and more initiative in developing research techniques and more responsibility in setting up projects.

How does a research scientist support himself?

Almost all active medical researchers have been awarded some kind of fellowship. Very few are salaried employees of industry. Research fellowships are awarded by universities, hospitals, industry, government, private research foundations, or by voluntary health agencies such as the American Heart Association. Fellowships usually include a generous living allowance. They may be part-time or full-time and may last anywhere from three months to a lifetime. Many researchers supplement their incomes by teaching. Average yearly income is therefore difficult to predict. In fact, it can vary considerably from year to year.

— E. H. HARVEY JR.

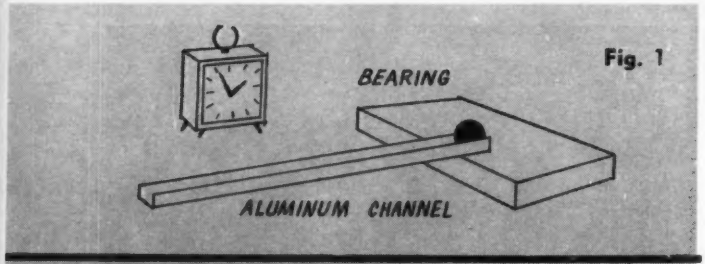
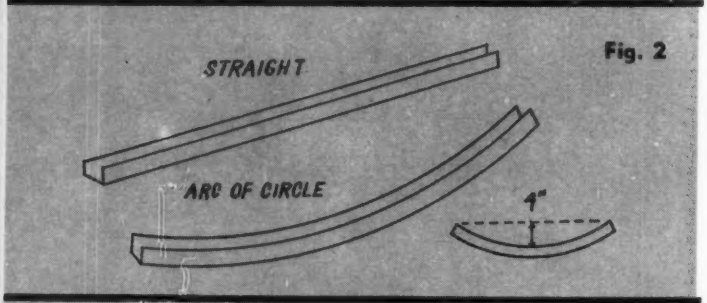


Fig. 1



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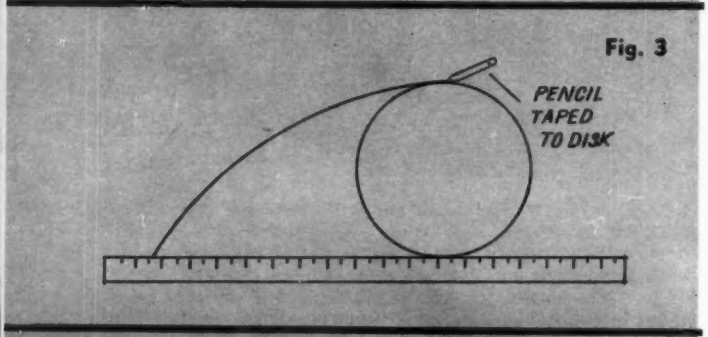

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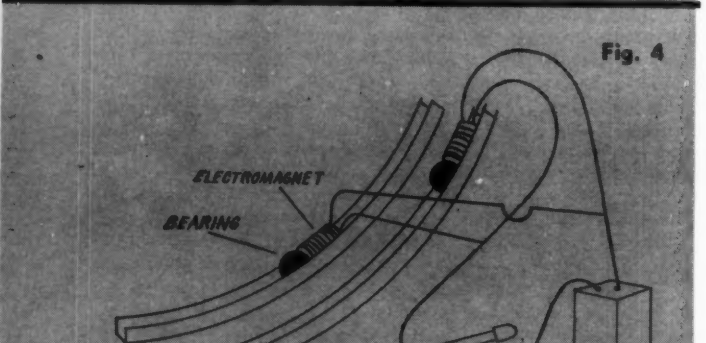


Fig. 4

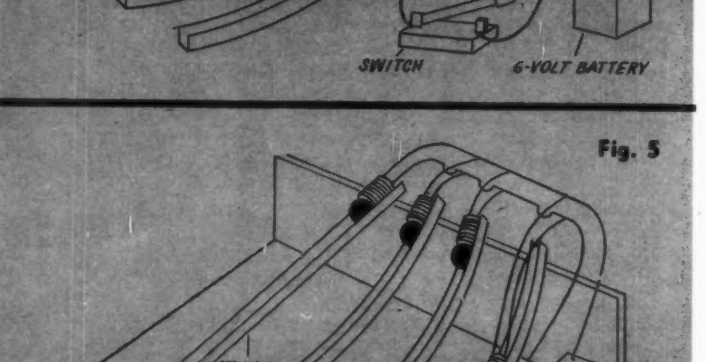


Fig. 5

WHICH IS

Leonard Maximum had just finished studying about falling bodies in physics class and about the plotting of curves in math class. This fortunate coincidence gave rise to a most unusual project. It was to win for him one of the top honors in his local science fair.

Leonard became interested in the laws of acceleration as they apply to bodies rolling down an incline. He decided to do some experimentation on this topic at home. For the incline, he used a three-foot length of aluminum channel. Then he obtained several ¾-inch steel ball bearings that could roll freely in the channel. He propped one end of the channel on a piece of wood. The incline was such that the ball bearing rolled with slowly increasing speed down the track. He then fastened a tape measure along the side of the track.

By counting the ticks of an alarm clock (a metronome could also have been used), he timed the rate of descent of the bearing (Fig. 1). His findings: a bearing takes half as long to roll down the first quarter of an incline as it takes to cover the remaining three quarters; the ball rolls four times as far in two seconds as it does in one, nine times as far in three seconds as in one, and sixteen times as far in four seconds. Leonard deduced that the acceleration due to gravity causes the ball to roll, in any given time, a distance that is directly proportional to the square of the time. Of course, this did not come as any great surprise to him. He had already learned that the same law holds true for any freely falling body.

Leonard wondered whether this law also holds true when the incline is curved in the plane of the vertical. He decided to experiment.

He bent a second aluminum channel into the shape of a segment of a circle. He did this by laying the two straight pieces channel-side-down on the floor. Then he bowed one channel until its center was about four inches from the center of the straight channel when its ends touched the ends of the straight piece. (See Fig. 2.)

He was now ready for his experiment. He lined up the curved track alongside the straight one. The upper ends of each were at the same height. He started a ball at the top of each of the two tracks at the same time. The ball rolling down the track that was shaped like a segment of a circle reached the bottom first.

Drawings by LoCurcio

THE FASTEST TRACK?

He demonstrated the experiment to his physics class at the Bronx (N.Y.) High School of Science. But he was careful to be very scientific in the conclusion he drew from it. The experiment showed, he said, that the rate of fall along *this particular track* was faster than it was along a straight track. Everyone seemed quite interested in Leonard's demonstration. The question arose as to whether the arc of a circle provided the fastest path from the top of the track to the lower end. When the discussion was continued in math class, the teacher suggested that Leonard investigate the properties of a cycloid.

As far as Leonard knew, a cycloid might have been a new kind of bicycle. But he did some reading. He learned that the cycloid was the curve for which he was looking: a ball rolling down a cycloid takes less time to reach the bottom than it does to cover any other pathway between the two points.

A cycloid is a curve traced by a point on the radius of a circle as the circle rolls along a straight line. Leonard set about constructing a cycloid track. He taped a pencil to the edge of a large flat disk made of plywood. He placed the disk, with the pencil attached, on a large piece of paper. He then rolled the disk along a yardstick (Fig. 3), making certain that the disk did not slip. Then, using the penciled curve as a template, he bent a piece of aluminum channel to conform to the curve. He now had three tracks, which he set up in the classroom. The balls rolled down the tracks. First to reach the bottom: the one on the cycloid. Next was the ball on the arc of a circle, and last was the one on the straight track.

But Leonard, in his reading about the cycloid, had come across a fact he could hardly believe: no matter where you start two balls on identical cycloids, they will both reach the bottom at the same time!

Leonard immediately made another cycloid track identical with the other. He tried the experiment. Sure enough, no matter where the balls were started on the tracks, they arrived at the bottom together. Here was something for the science fair. This idea would be the basis for a wonderful project. There were a few refinements, however, that had to be made. The balls had to be started at the same moment. Since the ball bearings were made of a magnetic material, electromagnets operated from a single switch would insure their being released at the same time. Leonard went to his junk box and found an old door bell. He removed the two small electromagnets from the bell. He mounted one in each of the two cycloid tracks in such a way that its position along the track could be shifted. He then wired them in parallel, through a knife switch, to a six-volt battery (Fig. 4). With the switch on, the balls were held in position. When the switch was opened, the balls were released simultaneously to roll down the cycloids.

Project's final form

He now began work on the final form of the project. Fig. 5 shows how he arranged his four tracks. To heighten the dramatic effect, he mounted a microswitch at the bottom of each track. As each ball struck its microswitch, a small, battery-operated flashlight bulb was lighted.

When the construction phase of his project was complete, he prepared his explanatory material. In a center panel just behind the tracks appeared the title of his project, "The Cycloid and Falling Bodies." Beneath was a brief description of the nature of a cycloid and how the cycloid track was constructed. In a panel at the right, he described the results of his experiments, giving actual data. In a left-hand panel, the viewer was told of the unique properties of the cycloid and encouraged to try the experiment for himself.

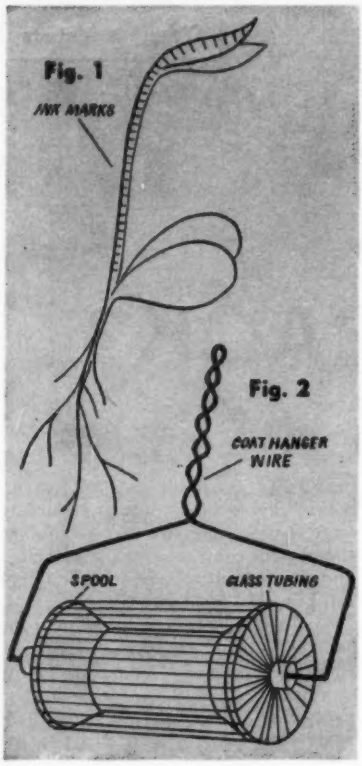
At the front of the exhibit, near the control switch, was a full set of instructions for performing two demonstrations. The spectator was asked to close the switch and set the balls against the electromagnets in the first three tracks. He was then told to open the switch and note the rate of descent of each of the balls. Attention was now called to the two cycloid tracks. It was suggested that the electromagnet on the fourth track be put into any position along the track. A ball was to be started in each of the cycloid tracks. The spectator was to note that the two balls arrived at the bottom at the same time.

Leonard won the first prize in his class for the project. His picture appeared in the local newspaper. Though this all happened a number of years ago, his teachers still talk about it.

Like all worthwhile projects, this one invites further investigation. The mathematics related to the project would be a study in itself. What, for example, is the equation for plotting a cycloid? How does the acceleration of an object falling along a cycloid vary?

Here is something you might try for yourself. Draw a circle on a piece of paper. Then add a chord of the circle, with one end of the chord at the bottom of the circle. Now draw a series of chords of this same circle so that all have a common end at the point at the bottom of the circle. Do this until the final chord is upright and is the diameter of the circle. If each of these chords were a track along which a ball rolled, how would the time of descent vary from track to track?

[*More projects on p.* 24]



TO DETERMINE what part of a seedling grows the most, regularly spaced ink marks are made along stem (*top*). Device at bottom is for marking stems.

Measuring plant growth

Sometimes the knowledge of a particular technique can open up a whole new field of project possibilities. Take, for example, the method of determining which part of the stem of a lima bean seedling is the region of greatest growth. Here are some ways to do it:

Bend a three-inch piece of coat hanger wire into a V. Connect the ends by a single strand of fine thread stretched out taut. Moisten the thread with India ink. Hold a ruler or scale against the seedling's stem and, with the inked thread, mark the stem at intervals of exactly ¼ inch. As the stem grows, the ink marks will be farther apart. Measure the space between them to determine the place where the stem has grown most rapidly.

A large number of stems or other parts of plants can be marked quickly by using the apparatus shown in Fig. 2. It consists of a small spool with a thread wound around it at regular intervals. The spool revolves on a wire handle. It can be made as follows:

Cement a short length of glass tubing into the hole in the spool to act as a bearing. Make shallow cuts in the spool flanges so that the threads will be evenly spaced. This can be done by fastening two razor or knife blades together with a spacer of cardboard or wood one millimeter thick. Press this double knife against the two flanges of the spool to make two cuts in each. Then move the blades on so that the first one rests in the second cut, and press down again to make a fresh cut in each of the two flanges. Continue this procedure all around the spool. Now wind a thread firmly through each successive cut, as in the illustration. Put a piece of coat-hanger wire through the glass tubing to serve as a shaft. Bend and twist the ends to form a handle. The thread can be inked by rolling the spool over a wad of absorbent cotton saturated with India ink.

With this device, any part of a plant, even if bent or crooked, can be rapidly and accurately marked. It will be particularly useful if a large number of seedlings are to be marked.

Tips for better projects

What makes the difference between a run-of-the-mill project and a prize-winning one? Usually, the difference is in the way a project is developed. Here are some tips and suggestions that should help you produce a top-notch project.

1. *Select a subject that interests you.* You should also know something about it. Your project should further your understanding of science and contribute to the work of your science class.

2. *Learn everything you can about the principles involved in your project.* Check textbooks, reference books, magazines, and other sources.

3. *Present a new idea or an old one treated in a new manner.* Do not repeat exactly what someone else has done.

4. *Start early.* Allow enough time to work without rushing and to make final refinements before the completion date.

5. *Make careful plans.* Draw diagrams. Be sure the project will conform in size and meet all specifications for any contest in which it is to be entered. Make a list of materials needed, and be sure you can get all of them. Estimate the cost so you will know whether you can swing it.

6. *Get approval of parents and teacher.* Discuss with your parents how the project's cost will be defrayed. Then submit your plans to your science teacher. He can spot an impractical project and indicate the stumbling blocks you are likely to encounter. He will probably make suggestions and correct any errors or mistakes.

7. *Build your project neatly and sturdily.* Neat, unhurried work pays off. If you are doing your project at home, be sure to clean up properly after each work session. And remember that the product of so much of your effort should be able to stand up under the handling it will receive.

8. *Make the project tell its own story.* Label and identify all parts. Any art work should be neat, clear, and attractive. Be sure to include the sources of your information.

9. *Give credit to those who have contributed ideas or helped.* Note clearly and emphatically how much of the project represents your own thinking and experimenting.

10. *Let others know what you have done.* A well-executed project can win acclaim for your school, your teacher, and yourself. In addition to improving your classroom grades, it may even win a scholarship for you. So exhibit your project whenever you can. And submit it for publication. SCIENCE WORLD, for example, may publish a write-up of your project and, if so, will pay you for it. (For details, see the announcement below.) This would in no way interfere with any of your rights in the project. It would, however, help others to recognize the value of project work.

— THEODORE BENJAMIN

TELL US ABOUT IT

Have you done an interesting science project? If so, tell us about it. We will pay $15 for any student project submitted by an SW reader and published in "Young Scientists." The description of your project may be typewritten or legibly handwritten. It should be accompanied by any necessary illustrations, as well as the written approval and signature of your teacher. Publication in SCIENCE WORLD in no way interferes with your right to use the project elsewhere. We regret that no contribution can be acknowledged or returned. Send to: Science Project Editor, Science World, 575 Madison Ave., New York 22, N. Y.

Mr. Binder's research seemed perfectly harmless, though it was anything but.

And Mr. Madden should have known enough to beware of

Mr. Binder and the solid vacuum

By Murray Leinster

Unfortunately, in his retirement on pension from the electric-light-and-power company, Theodore Binder does research. He reads, gets ideas, and tries them out. There are times when I think we'd be safer if he made atom bombs in his kitchen laboratory. . . .

He investigated the idea of compenetration, once. That is the philosophical notion that two things can occupy the same space at the same time, and it sounds harmless. But when Mr. Binder got through with it, he and seventy-one other persons had been heaved violently into what can only be described as the middle of the week after next. In the process they lost their small change, the nails out of their shoes, and the fillings out of their teeth. They were also unpleasantly surprised.

That was mild, of course, but it's the suspense that hurts. Nobody can guess what Mr. Binder will accomplish next. Even his best friend, Mr. Madden, has grown suspicious. The other day Mr. Madden went to call on him. Mr. Madden is also retired from his career as skipper of a charter-boat for fishing parties. His son runs the ancient fishing-boat now, and Mr. Madden disapproves. Mr. Madden went to Mr. Binder's house and rang the doorbell. Mr. Binder answered it.

"Why, George!" he said cordially, at sight of Mr. Madden's sunburned jowls. "George! Come in! I've got something to show you!"

"Hold it!" said Mr. Madden sternly. "I've troubles and I need consolation, but not one step do I come into your house if you've notions of showing me your scientific triumphs!"

"It's not a triumph," protested Mr. Binder. "It's a failure. It's only something I worked out from soap bubbles."

Mr. Madden considered, then yielded. "If it's only soap bubbles," he conceded suspiciously, "it could be harmless. But I've got troubles; I've no mind to have them increased. Nothing controversial, now! I'm allergic to it!"

He stamped inside. Mr. Binder led the way happily to his kitchen. There were curtains at the windows, from the time before he was a widower. An icebox whirred merrily by one wall. But beside another wall stood a workbench, and the chairs held burdens of coiled wires and tin cans full of rusty bolts, and there were mysterious substances in screw-top jars that once had held preserves. Mr. Binder cleared a chair by removing a breadboard, handdrill, and a cup and saucer with coffee in it.

"You'll be amused," said Mr. Binder ingratiatingly. "I got interested in soap bubbles, and that led to surface tension, and that led to — well, George — I made something that you might as well call a vacuum. But it's a new kind of vacuum. It's solid."

Mr. Madden sat, foursquare and with his knees apart. "Well, now," he admitted, "that might not upset me. They use vacuums in electric bulbs and such. There's vacuum cleaners, though why anybody should worry about a dirty vacuum . . ."

Mr. Binder laughed delightedly. Mr. Madden thawed at this appreciation of his impromptu wit. But he said mournfully:

"I've troubles on my mind — that boy of mine, running the old *Gertrude* that I took fishing parties out in for twenty years. I shouldn't ha' turned her over to him. He's got her up on a marine railway. A railway, understand! And he says she has to have a new engine. She's too slow, he says! Fishin' parties don't want speed. They want fish!"

Mr. Binder offered hospitality. He turned up the gas under the coffeepot.

Mr. Madden took off his hat and coat and loosened his suspenders. "All right," he said, "I'll listen. After, I'll tell you about my boy wantin' to put twelve hundred dollars in a new secondhand engine for the *Gertrude*. It's outrageous!"

Mr. Binder beamed. He went to his workbench. He loosened the vise

Adapted, by permission of the author, from a story that originally appeared in Startling Stories *for October, 1953; copyright 1953 by Better Publications, Inc.*

and removed a six-inch piece of wooden rod which had been held fast in it. One end of the rod glistened faintly. He showed it to Mr. Madden.

"You'd never guess it, George," he said happily, "but that's practically a vacuum on the end of this stick. Feel the wind!"

He held it close to Mr. Madden's weathered cheek. There was a distinct brisk wind blowing sideways from the cut-off end. Mr. Madden raised his hand to take it, and Mr. Binder jerked it away.

"Not yet, George," he said apologetically. "You might get hurt if you don't understand it first."

"Then put it away," said Mr. Madden heavily. "It's controversial!"

Mr. Binder protested: "Look, George! Like this!"

He picked up the breadboard. He presented the shiny end of the stick to it. There was a slight burping noise. There was a slight misty appearance. The wooden rod went through the breadboard. Mr. Binder withdrew it, and there was a neat hole there. Mr. Madden's jaw dropped. Mr. Binder picked up a section of sheet-iron. The noise was rather more like a hiccough than a burp. The wooden rod went through, leaving a hole. Mr. Binder picked up an empty bottle. The wooden rod chirruped. It made a hole in the glass bottle. There was again a misty appearance.

"Well, now!" said Mr. Madden, intrigued. "There's a fancy drill you've got there! What does the cutting?"

"What I call the vacuum," said Mr. Binder modestly. "It's really something that's got surface tension so high that it won't let anything touch it. Anything that comes in contact with it, it throws away. Sideways. Even air! That's why I call it a vacuum."

"What're you going to do with it?" Mr. Madden asked.

"I can't do anything with it," said Mr. Binder regretfully.

"Hm, now!" said Mr. Madden. "It'd ought to be good for something!"

"It's just painted on the end of the stick," said Mr. Binder. "It's very easy to make. I did think I'd give it to the Government for the Army. For bulletproof clothes, you know. It can be painted on cloth."

Mr. Madden blinked.

"Bulletproof clothes?" he asked. "To put on a bayonet, now . . ."

Mr. Binder said regretfully, "Make believe this is a bullet." He picked up a spanner and swatted the end of the wooden stick. There was a noise. There was a darkish mist in the air. But the spanner didn't hit the stick. The stick went through the spanner. There was a hole. "If a bullet hits a piece of cloth with this solid vacuum on it, the bullet gets thrown away sideways in powder. This solid vacuum doesn't like anything! A man with clothes on that were solid vacuum outside — you could turn a machine gun on him or shoot at him with a cannon, and nothing could get through to him."

"Ah!" said Mr. Madden with approval. "That's a fine, patriotic invention. What did the Government say?"

"No use showing it," said Mr. Binder regretfully. "A man in a solid-vacuum suit couldn't sit down."

Mr. Madden looked his question. Mr. Binder pointed to the shiny end of the stick.

"That's the seat of his pants," he said. He touched the suppositious seat of somebody's pants to the seat of a kitchen chair. It went through. There was a hole.

"Mm," said Mr. Madden gravely. "They'd have to sit on the floor."

For answer, Mr. Binder touched the shiny stuff to the floor. It went through. He said, still bent over, "I haven't the nerve to let go of it. It ought to go on down to the center of the earth. I'd guess it would."

He straightened up and put the stick back in the vise.

"I thought you'd be interested, George. Now, what's your trouble?"

Mr. Madden waved away the question. He was envisioning somebody who was wearing a suit of the stuff on the end of the stick and who had just sat down. Mr. Madden saw that he would go bumbling down through solid earth and rock, on downward indefinitely. There appeared to be drawbacks to solid vacuum as wearing apparel. But then he slapped his hand on his knee.

"Give him," he said authoritatively, "an ordinary seat to his pants. That's it!"

But Mr. Binder shook his head and sighed.

"No. He might stub his toe. If he fell flat on his face, it'd be just as bad as if he sat in the usual way, George."

"That's so," conceded Mr. Madden.

Mr. Binder said, with a gesture toward the wooden rod in the vise, "You noticed I didn't dare put it down? There's a vacuum in front. It's always trying to get pulled into that vacuum. Only of course it couldn't be. If I pointed it up at the sky and let go, it'd go shooting off I don't know where. Straight up. Pulled by the vacuum. What's your trouble, George?"

Mr. Madden cleared his throat. He did have troubles. But Mr. Binder had proposed a problem, and Mr. Madden was not one to let an intellectual riddle go unsolved. He held up his hand.

"It's obvious," he said sternly. "Why didn't you realize it? You can paint that stuff on cloth. Take an umbrella and paint it with solid vacuum. Then you hold on to the handle and open the umbrella. You'll fly. Close the umbrella, and you'll come down. Just like that!"

But Mr. Binder shook his head yet again. "Sometimes an airplane gets turned upside down," he said sagely. "It often happens. And if it hit the ground upside down — besides, George, where could you hang up an umbrella like that? No," said Mr. Binder depressedly, "no, George, it's just one of those inventions that's a good idea, but impractical!" And then he sighed and said encouragingly, "What's on your mind, George? You said you had some troubles."

Mr. Madden sighed in his turn. "It's that boy of mine," he said pathetically. "He's got the old *Gertrude* up on a marine railway, and he says she's got to have a new engine. And there's been nothing the matter with that engine the past fifteen years. Twelve hundred dollars he wants to spend! Just to take people out to the fishing-grounds faster! And I've got to take the money out of the bank for him to waste on engines!"

Mr. Binder said "Tsk, tsk." He listened while Mr. Madden unburdened himself.

At long last, Mr. Binder said hesitantly, "George, there's something I could suggest. If this solid vacuum of mine could be made into Army uniforms it'd be a military secret. But it can't. And it isn't practical for airplanes or anything else. But it is a good vacuum. I could put some of it on the bow of the *Gertrude*. It'd try to pull the boat along. It might make her go faster, and I'm sure it'd save gasoline."

Mr. Madden blinked.

Mr. Binder went on meditatively, "And it ought to be safe. You don't run into things with boats, like cars. And this'd be just on the bow, and the boat'd be kept balanced by the rest of it, so it wouldn't start for the sky. And boats don't turn over — only sailboats — and moreover I could put it on canvas, instead of the planks, so we could always take it off. Suppose I try it, George?"

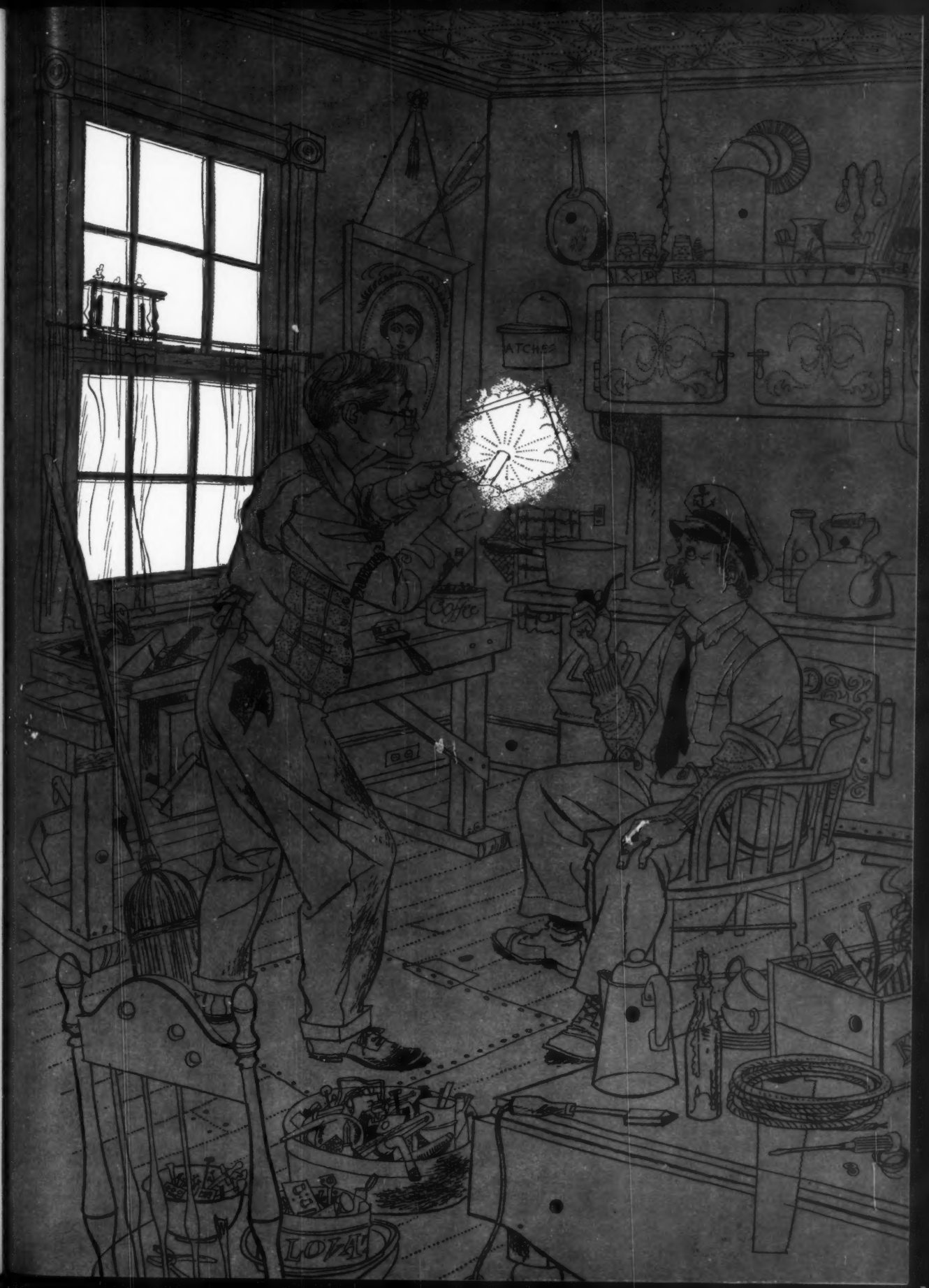
Mr. Madden had been depressed on his arrival, but he was now uplifted.

He said: "Y'know, the more I think about it, the gladder I am that I've got a friend like Thaddeus Binder."

Little did he know.

[*To be concluded in October 28* SW.]

— Illustrated by Paul Granger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The Society of Exploration Geophysicists has prepared a thorough review of this field. *Careers in Explorations Geophysics* answers: How does exploration geophysics work? Where will you work? Where will you begin, and how will you advance? This sixteen-page study is heavily illustrated and contains helpful charts and curriculum guidance. Request No. 10149.

About the contributors

BEN BOVA writes movie scripts for the Physical Science Study Committee as part of the project to redesign high school physics courses. Before that, he was technical editor on the Vanguard Project for the Martin Company. Mr. Bova entered the science writing field via a degree in journalism from Temple University and newspaper and magazine work in the Philadelphia area.

ISAAC ASIMOV first turned lexicographer for *SW* readers with his article last November on the naming of the elements. Material for "Winged Words" in this issue is drawn from one of Dr. Asimov's new books, *The Words of Science*, to be published by Houghton Mifflin in 1959. The book contains the derivations of some 1,500 words used in all branches of science.

A degree in chemistry prompted FREDRIC C. APPEL to widen his scientific interests and combine them with his talent for writing. He was until recently a staff editor for *The Book of Popular Science*, published by The Grolier Society, and has written articles on nuclear physics, medicine, and chemistry for a variety of publications. Last month he went into the Army, but hopes to continue science writing.

Author MURRAY LEINSTER divides his time between a home on Long Island and one in Virginia — with a galaxy of science fiction as the result. He has contributed to *Collier's*, *The Saturday Evening Post*, and a host of magazines in the popular field, has written virtually a bookshelf of fiction, and has also edited s-f anthologies. He is an inventor, too, but, unlike Mr. Binder, has several patents to his credit.

About 'The Goose'

Isaac Asimov's s-f puzzler, "A Very Special Kind of Goose" (*SW*, Sept. 25), draws forth many different solutions from many different minds. Here is one of the more plausible:

DEAR DR. ASIMOV:

If The Goose is making gold out of oxygen 18, the obvious first answer is to keep her away from oxygen 18.

The problem has the interesting characteristic that the only way to get golden-egg-laying geese is to make The Goose stop laying golden eggs! But while it's easy to say, "Keep out the oxygen 18," the next problems are "How?" and "How completely?"

The Goose is, however, perfectly equipped to solve the problem. At Argonne National Laboratories they already have completely sealed greenhouses, where they grow plants in radioactive atmospheres. Dump one of those greenhouses, plant necessary ordinary weeds and install The Goose and a gander and leave them alone. In a sealed system, if one component is irreversibly transformed into something else, the system will be freed of the initial component eventually. The Goose herself, then, is the best mechanism for removing the O-18 from air, food and water; she'll turn it into gold. Once in a completely sealed environment, in a few weeks or months all perceptible O-18 will be used up and The Goose will stop laying golden eggs and start hatching goslings.

Since geese are plant-eaters, all they need to keep going is plants, water, and plenty of sunlight to make the plants grow. This the two geese can get readily in a greenhouse.

When the goslings hatch, research can proceed on the next question: If this type of goose turns O-18 into gold and has to get rid of it in the eggs to keep alive — can a gander of the type live at all? He can't throw away gold in the form of eggshells!

Sincerely,
DON A. STUART

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What is the highest temperature achieved in a jet flame?

The highest sustained temperatures have been produced not in jet engines but in high-pressure jet torches. In these, a jet of air is heated to temperatures of up to 26,000° F. by a powerful electric arc. Hot jets are used to study the effects of extremely high temperatures on new materials and designs. One such device, for example, is helping scientists test nose-cone shapes for ballistic missiles (see photo). A ballistic missile is shot in a high arc that takes it to the fringes of space. When it hurtles downward at high speed through thicker layers of atmosphere, its nose cone is heated to tremendous temperatures by air friction.

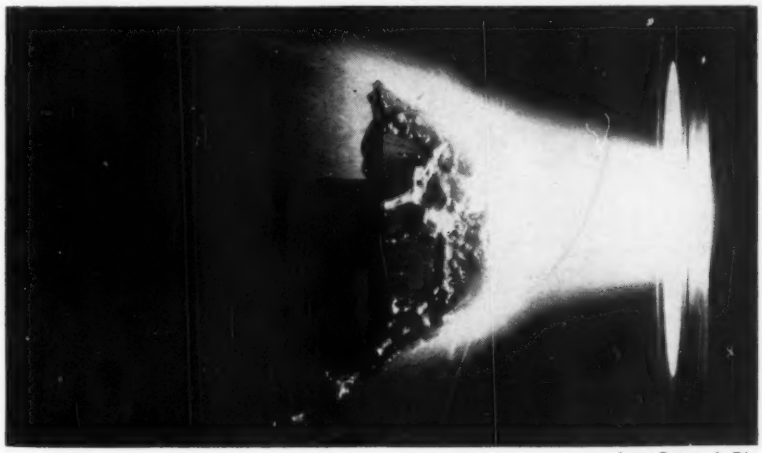
Are cockroaches harmful to man?

They have long been suspected of carrying infections from refuse and sewage to human food. The Army Quartermaster Research Center has reported that about forty species of bacteria, as well as the virus of yellow fever and four strains of polio virus, have been isolated from cockroaches. But no direct relationship between roaches and specific outbreaks of disease has ever been proved.

Sunspots are supposed to be storms in the sun's atmosphere caused by hot gases erupting from the sun's interior. But they look darker than the rest of the sun and so must be cooler. How can this be explained?

Dr. Donald H. Menzel of Harvard College Observatory has a theory to explain it. A gas from the sun's interior is so hot that its atoms collide violently. In these collisions, electrons are detached from most of the atoms. The gas is then a good conductor of electricity. Any electric currents in it form magnetic fields. These give the gas a degree of rigidity, as if it were a semisolid. Thus the violent turbulence is reduced. The resulting sunspot is now an "island of tranquility" where hot gases no longer erupt by convection from the very hot interior. If the sun's surface were one big sunspot, the whole surface would be at least 2,000° cooler than it is now. The amount of energy radiated by the sun would be vastly less than it is now.

SUPER-HOT JET FLAME blasts metal from experimental ballistic-missile nose cone.



— Avco Research Div.

Is there life at the very bottom of the deep seas?

Columbia University's research vessel, the *Vema,* recently used a nylon net to trawl the bottom of the Atlantic three miles down. The net came up with clams, snails, starfish, sea spiders, worms, sponges, crinoids, and crustaceans. From the Congo Submarine Canyon, 13,000 feet down off the coast of Africa, came a live sand flea. Only one eighth of an inch long, it resembled a tiny lobster. In being brought from the bottom to the surface, it survived a pressure change of 6,600 pounds per square inch. Perhaps it was able to remain alive because it has no air sacs to swell and burst. A worm only a quarter of an inch long was also alive after being lifted more than 16,000 feet to the surface. The pressure drop in this instance was more than 8,000 pounds.

Why is 1958 the centennial of Darwin's work? Didn't he publish his "Origin of Species" *after* 1858?

Yes. The book was first published in 1859. Charles Darwin had been developing his ideas on evolution and natural selection for many years. In 1858, the much younger Alfred Russel Wallace also conceived the idea of natural selection and sent his theory to Darwin. They agreed to present their preliminary papers jointly before the Linnean Society. That was in 1858. So 1958 is the centennial of the announcement of the theory, but not of the famous book.

Can plants grow, without irrigation, where it never rains?

There is no place on earth where there is no rain at all. There are places, though, where it may sprinkle only every few years. This is not enough water to support vegetation. But there are deserts, usually near the ocean, where plants grow even though rain is very rare. Here, fog is not uncommon and dew often forms at night. Some plants, including the tomato, are able to absorb dew from their leaves and exude the water through their roots into the soil. They can then use the moisture for growth during the following sunny day. — GERALD WENDT

Questions from readers will be answered here, as space permits. Send to: Question Box, Science World, 575 Madison Avenue, New York 22, N.Y.

On the light side

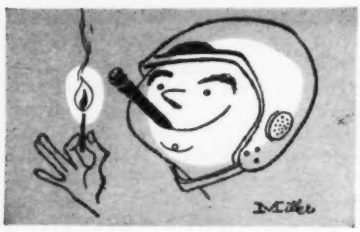
Brain teasers

Odds on eggs

Two of six eggs in the refrigerator are bad, but you don't know which two. If you pick two eggs at random, are you more likely to get a bad egg than not?

Digits in reverse

See how fast you can write the digits from 9 to 1 *backwards*, then check the answer to see how carefully you followed directions.



Smoke in space

The picture above shows a space pilot strapped to his seat inside a rocket spaceship. The pilot is just about to light his cigar. The ship is in a state of "free fall," so a condition of weightlessness prevails inside. Can you spot the scientific mistake the artist made when he drew the picture? (See Answers.)

Lightning addition

Anyone can be a lightning-fast calculator if he knows the secret of this addition trick:

Ask someone to write any five-figure number on the blackboard. You then write a five-figure number beneath it, apparently at random. Actually, you choose your digits so that each one, added to the digit above it, will total nine. For example:

His number: 45623

Your number: 54376

Tell the person to put a third five-figure number beneath your number. You then write a fourth number, using the same nine-principle. After he has written a fifth number, you draw a line under it and without a moment's hesitation write the correct total. More startling still, you write it from left to right!

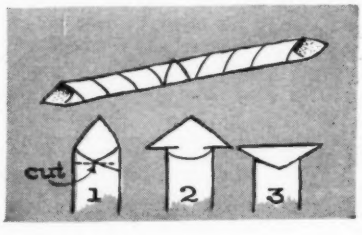
How do you do it? Just subtract 2 from the fifth number and put 2 in front of what is left. For example: if the fifth number is 48765, the total will be 248763.

Paper reed

The tones of all reed instruments, such as clarinets, saxophones, and oboes, are produced by rapidly vibrating reeds. The principle is easily demonstrated with a square sheet of paper.

Put a pencil at one corner of the sheet. Roll the paper around it, twist a rubber band around the roll, then shake out the pencil. You now have a rolled paper tube, pointed at both ends. At one end, cut the corner as shown and bend over the triangular flap to make your "reed."

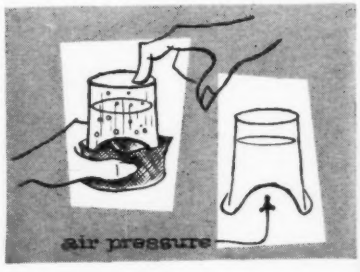
Put the other end of the tube in your mouth and gently *inhale*. The paper triangle will vibrate and give forth a strong bass tone. By cupping your hands around the reed, then opening and closing one hand, you can produce an amusing imitation of a mooing cow.



Boiling without heat

Years ago I saw a gypsy woman perform the following feat as a demonstration of her supposedly magic powers. She filled a drinking glass with water, then covered it with her handkerchief, previously dipped in water. She pushed down the center of the cloth to form a kind of well, inverted the glass on her right palm, then seized it with her left hand as shown. Air pressure ballooned the cloth upward inside the glass.

"When I put my finger on the glass," she explained, "it will make the water boil." Sure enough, when she did so, streams of bubbles began rising through the water. You could even *hear* the surface bubbling!



What happened was this: when she pushed with her finger, the glass slid downward through her left hand, causing the handkerchief to slide upward on the outside of the glass. This lowered the center of the cloth inside, forming a vacuum. The vacuum drew air through the handkerchief's cloth fibers and created a perfect illusion of boiling water.

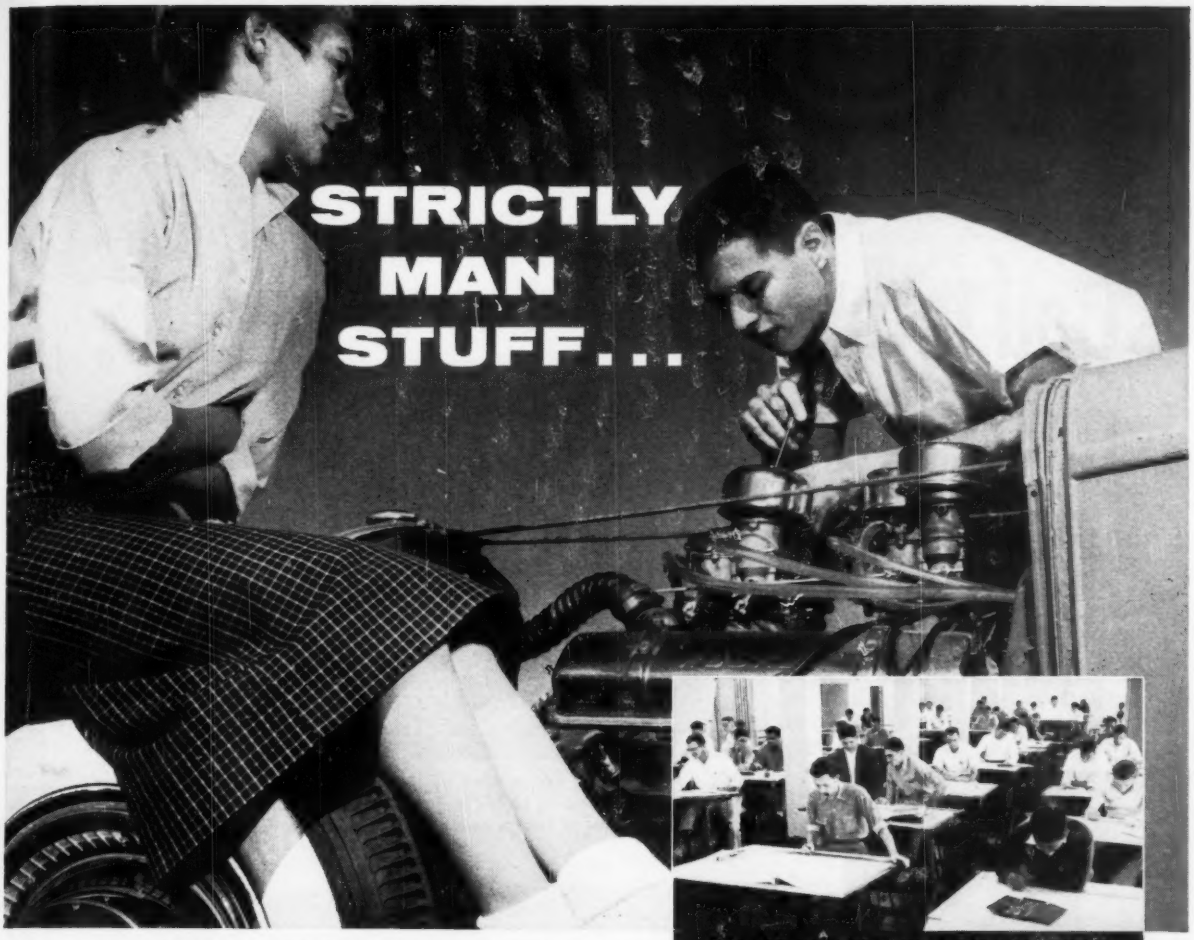
[NOTE: *This trick requires some practice. Be sure to do your practicing over the sink.*] — GEORGE GROTH

Answers

ODDS ON EGGS: Yes. Six eggs can be paired in fifteen different ways. If you assume that any two eggs are bad, at least one of them will be in nine of the fifteen pairs. Therefore the chance of getting at least one bad egg is 9:15, or 3:5 — better than 50 per cent. Your chance of getting *both* bad eggs, however, is only 1:15.

DIGITS IN REVERSE: The digits from 9 to 1 backwards are 1-2-3-4-5-6-7-8-9.

SMOKE IN SPACE: A steadily burning vertical flame, such as you see on the pilot's match, is not possible in zero gravity. It is gravity acting on air that gives buoyancy to the waste products of combustion, in turn producing the vertical flame. To keep his match lighted the pilot would have to wave it continually from side to side.



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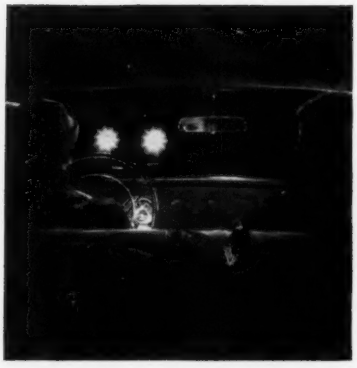
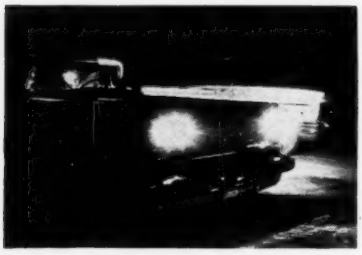
"Dad lets me drive

when we go hunting"

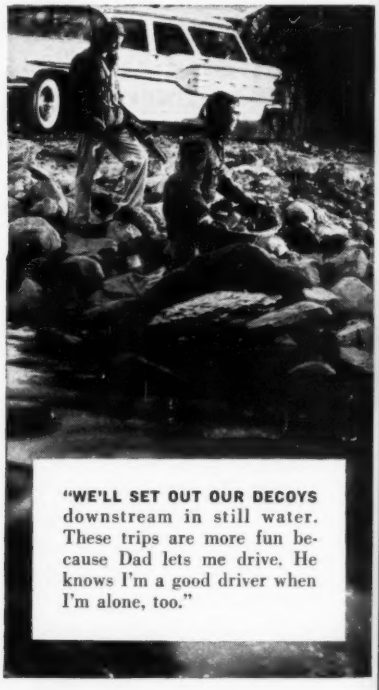
"DUCK HUNTING WITH DAD IS LOTS OF FUN. We tiptoe to keep from waking Mom, have a fast breakfast, then take off before dawn with *me* at the wheel. Dad lets me drive on all our trips because I'm just as careful handling the car as I am handling a gun."



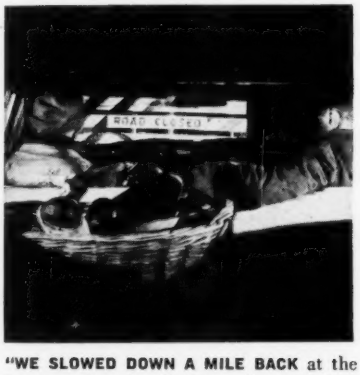
"I TRY TO THINK OF THE OTHER DRIVER, that's why I dropped my beams. He did, too—it makes the road safer for us both."



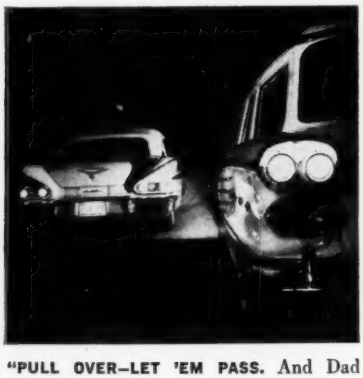
"WAY OFF THE ROAD is where we stop to read our map. We don't cause accidents by stopping where we shouldn't."



"WE'LL SET OUT OUR DECOYS downstream in still water. These trips are more fun because Dad lets me drive. He knows I'm a good driver when I'm alone, too."



"WE SLOWED DOWN A MILE BACK at the 'construction ahead' signs. Now we don't have to jam on the brakes—just find another route."



"PULL OVER—LET 'EM PASS. And Dad also taught me to get going early so we wouldn't have to speed to beat the ducks over our blind."

GENERAL MOTORS

YOUNG DRIVERS CAN BE SAFE DRIVERS

TEACHER'S TOOLS

ACE GLASS, INCORPORATED, has solved the student laboratory problem of broken desiccators. Ace's new "standard" plastic desiccator, Dura-Vac, is fabricated of Plexiglas. It is reported to be practically indestructible under ordinary laboratory conditions. Weighing only one pound, it's about one-fifth as heavy as comparable glass units. Light transmission is 92 per cent, affording an excellent view of desiccator contents. Every color of the spectrum is transmitted, and the Plexiglas withstands sunlight, which causes severe crazing or cracking in many plastics. The Dura-Vac is 7½" high and 6¾" in diameter. Inside diameter is 6⅛". Heavy objects such as hammers and wrenches were dropped from heights of up to six feet in deliberate attempts to cause breakage. Only a few minor chips resulted. (*Check No.* 10141 *on next page for complete information on the new Dura-Vac.*)

HAMILTON MANUFACTURING COMPANY contributes to scientific accuracy and precise analytical weighing with its three types of balance tables. Reinforced construction of the table frame and legs results in a rigid unit that is extremely resistant to lateral movement caused by shock. The built-in damping devices are designed to absorb vibrations transmitted through the building structure. Hamilton's Imperial Balance Table (57W110-57P110) features a smoothly finished Imperial Stone top. Over-all measurements are 49" long x 24" wide x 30" high. Balance Table 57W120-57P120 is specifically designed for side-by-side installations of two balances. Master Balance Table 57W130-57P130 is recommended for installations where extreme accuracy is required. Massive two-inch-thick soapstone is mounted on Vibro- Insulators for complete damping of vibrations. Carrara glass top insert rests on a 1/16-inch felt pad. (*Check No.* 10142 *for complete information on Balance Tables and general line of laboratory furniture.*)

"MATERIALS FOR TEACHING CONSERVATION AND RESOURCE-USE," a 55-page bulletin, has been prepared by the National Association of Biology Teachers. It is available for 35¢ from Interstate Printers and Publishers, Inc., Danville, Illinois. The bulletin includes listings of *free* and *inexpensive* materials from state and national agencies, selected

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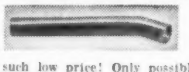

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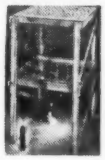

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references, films, and film strips. This helpful classroom teaching "tool" was prepared by various members of the NABT Conservation Committee.

SOME RULES FOR SAFE DRIVING during the hours of darkness are given in the General Motors advertisement on page 32 in this issue of the student magazine. Titled "DAD LETS ME DRIVE WHEN WE GO HUNTING," it was prepared especially for teen-agers. (*If you would like a reprint to post on your school or class bulletin board, check No.* 10143.)

'Tools' question box

Any questions on teaching tools? Send them to: "Tools" Question Box, Science Teacher's World, 575 Madison Avenue, New York 22, N.Y.

J.W.I., Houston, Texas: "Several of my students are interested in bird watching. What special equipment is needed in beginning such a study group?"

Answer: Why not begin with an inexpensive pair of opera glasses? Later you will probably want a pair of prism binoculars. Use lightweight 8 x 30 glasses. These have a magnification of 8X and a 30 mm. diameter, providing a wide field and good illumination. Remember, as magnification increases, the field decreases, and it becomes difficult to find a bird among leaves.

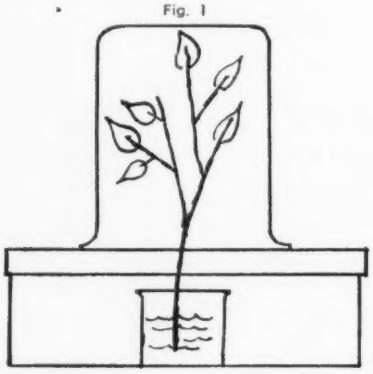
How to make it

Insect-observation cages

From summer to late fall, fields are alive with insects, spiders, and other invertebrates. Many of these can be brought into the biology classroom where students can observe their behavior, watch them feed, and witness the completion of their life cycles. Here are ways to handle some of the problems that may arise.

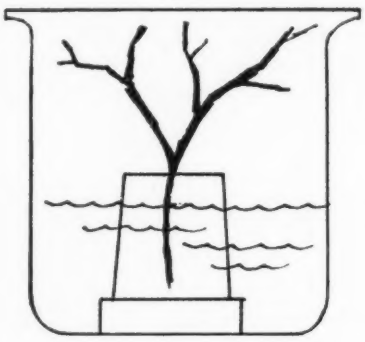
1. *Providing moist leaves for feeding.* Commonly, twigs with leaves are placed in a jar of water inside the insect cage. But the cage is often not large enough to accommodate the jar. Or, if the jar does fit, insects may fall into the water and drown. A simple arrangement that solves these problems is shown in Fig. 1.

Fig. 1



The cut end of a twig with appropriate leaves is pushed through a small hole in the top of a shoe box. The cut end is then placed in a jar of water inside the shoe box. An inverted battery jar is put on top of the box over the leafy end of the twig. The jar serves as the insect-observation cage.

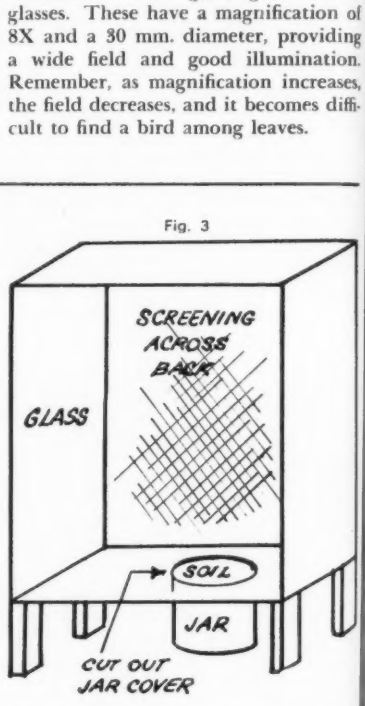
Fig. 2



2. *Keeping spiders in view.* Spiders placed in an observation cage are likely to hide in a corner and be all but invisible. To keep them where they can be seen, place them on an artificial island, as in Fig. 2.

An inverted flower pot is placed in a vessel of water. A twig with branchlets is put in the hole of the pot. A spider is placed on the island thus formed. Since a spider does not travel on water, it cannot escape. It may weave its web on the branchlets and feed on flies thrown into the web.

Fig. 3



3. *Soil for egg-laying.* For insects that lay their eggs in the soil, it will not do simply to place a dish of soil in the cage. Many such insects are positively geotropic and will not climb up into the dish to lay their eggs. An arrangement that "works" is Fig. 3.

The front of the cage is a glass window. The back is insect screening. A hole is bored in the floor to accommodate the cover of a screw-top jar. The cover should fit tightly in the hole. All but a narrow margin along the rim of the cover is cut out. The jar, filled with soil, is then screwed into the cover. To make room for the jar, the cage must rest on supporting legs.

Coming in SW October 28

Marksman of the Darkness: Report on experiments showing how the barn owl locates its prey at night.

Heat into Electricity: Reporting on exciting advances at General Electric and Westinghouse in direct conversion of heat into electricity.

IGY: Round-up of IGY probing of space.

The Senses of Man: How many senses do we have? The answer will surprise students. This article is based on the new TV program in the Bell System Science Series. You may wish to assign the class to watch the program and use the article as an aid to class discussion. The program will appear on NBC-TV at 8:00 P.M., EDT, October 23.

Science teacher's question box

Do you have any questions connected with your teaching? Questions about methods and techniques, content of science courses in junior and senior high schools, or related topics? They will be answered, as space permits, in "Science Teacher's Question Box," a new feature to begin in a forthcoming issue of *STW*. Send your questions to: Science Teacher's Question Box, Science Teacher's World, 575 Madison Avenue, New York 22, N. Y. Questions will be answered only in the Question Box. They cannot be answered by mail.

New Ford film available for student showings:

"AN EQUATION FOR PROGRESS"

A sound and color film, "An Equation for Progress" gives an over-the-shoulder glimpse of such men as the Wright brothers, Thomas Edison, and Henry Ford. Proving that progress is no longer a product of hit and miss activity, the film highlights today's "stepping stones to progress"—present research activities that will make tomorrow's products better.

Dr. Andrew A. Kucher, Ford Motor Company Vice-President, Engineering and Research, takes the viewer on a stimulating, 28-minute tour of past and present research and shows how "scientific research efforts are the building blocks on which the 20th century is built."

Schedule this 16mm film (no rental fee) for showing to your students. Fill out the coupon below and send it to the Ford Film Library nearest you. Because of the popularity of this new film, please indicate a first and second choice of showing date.

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Shop talk

Gas-filled balloons

Many science teachers find it impossible to inflate balloons by using the pressure from conventional gas generators. But, writes René M. Bernasconi of the science department of Lee (Massachusetts) High School, the problem can easily be solved with standard apparatus. He suggests the following technique:

Set up the apparatus as shown in the diagram. (The drying tube is essential only in buoyancy experiments.) Turn the faucet on slowly. This puts the gas under enough pressure to fill the balloon. If balloons resist inflation, warm them up first by holding them in your closed fist.

Gas-filled balloons can be used by teachers of physics, chemistry, and general science for the following:

1. To compare the buoyancy of gases. For this purpose, tiny weights may be tied to the balloons with string.

2. To explode gases, especially hydrogen, in a safe way.

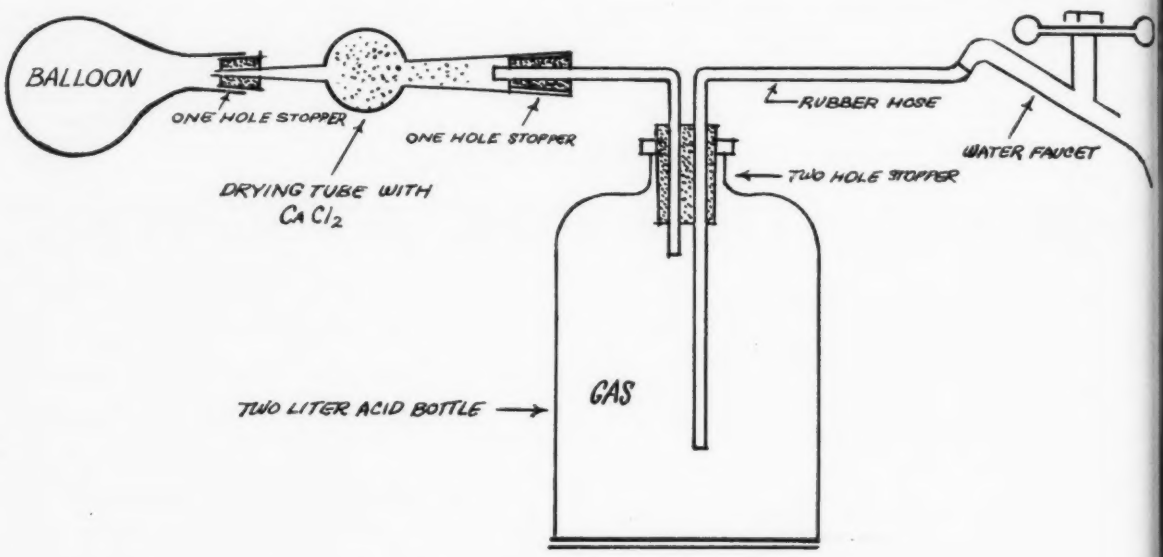
3. To illustrate the value of fuels in driving pistons.

4. To compare the ability of such gases as nitrogen and carbon dioxide to retard burning. A candle can be used for this purpose.

5. To explode fumes from home-drycleaning fluids (such as benzene) as a dramatic illustration of the danger in handling them.

Free reference books

If your science department suffers the chronic problem of needing reference books and lacking the funds to buy them, take note of a successful scheme used by the chemistry department of Charleston (West Virginia) High School. "This year," writes Miriam L. West, "we asked our graduates who had finished a year of college chemistry if they would lend or donate their first-year chemistry books for our library. The response was most gratifying. We now have an excellent library of up-to-date texts that our more advanced students can consult. And they didn't cost us a penny!"



STANDARD APPARATUS can be used as shown to fill balloons with gas.

We hope you'll consider "Shop Talk" a combination teachers' room, seminar, and conference round table — a meeting place where all good science teachers can come to the aid of one another by speaking their minds and sharing their experiences. Won't you send us news of unusual classroom experiments, problems, and/or triumphs?

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